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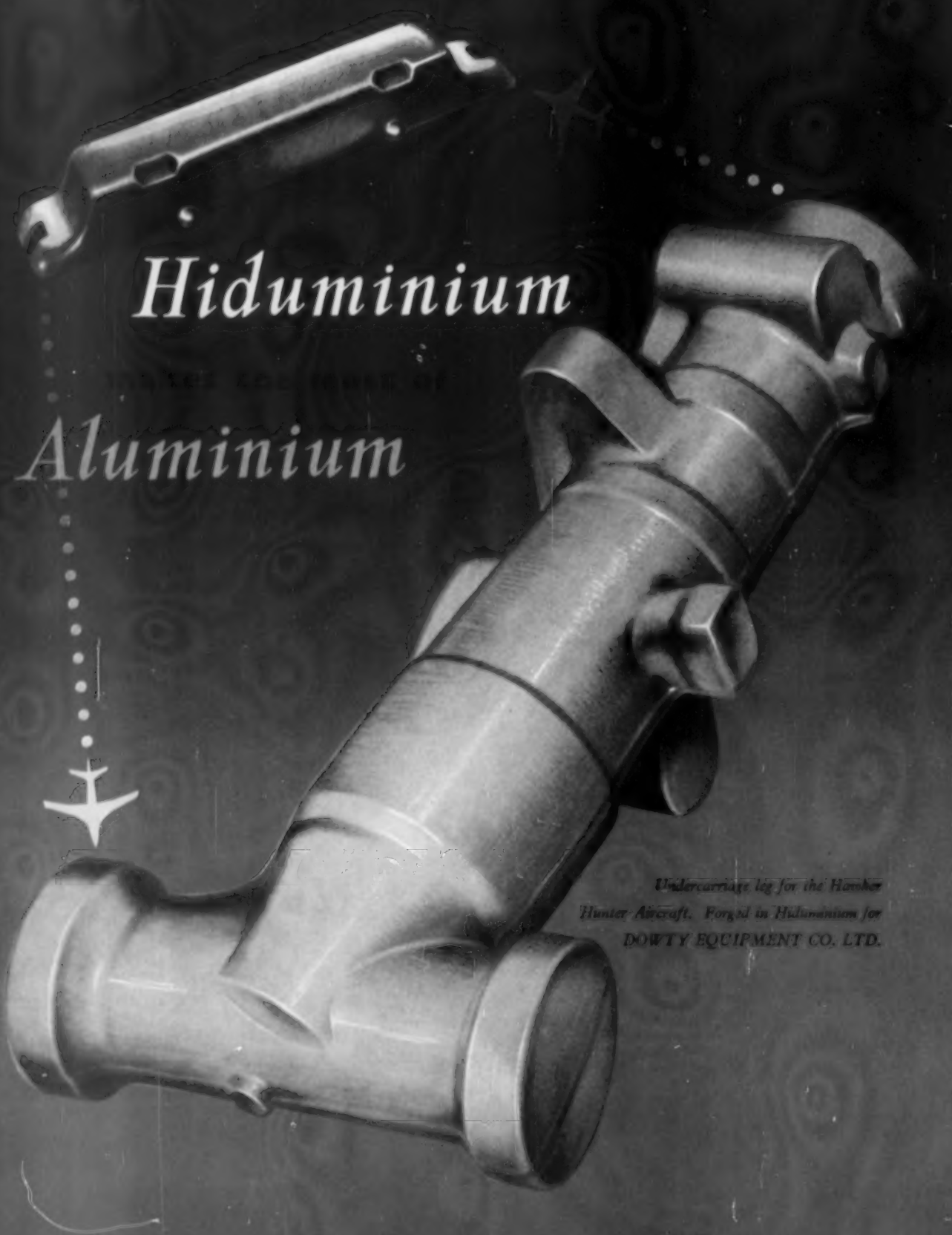

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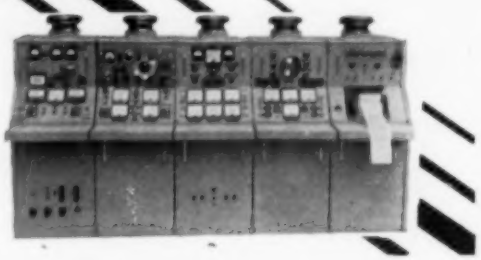

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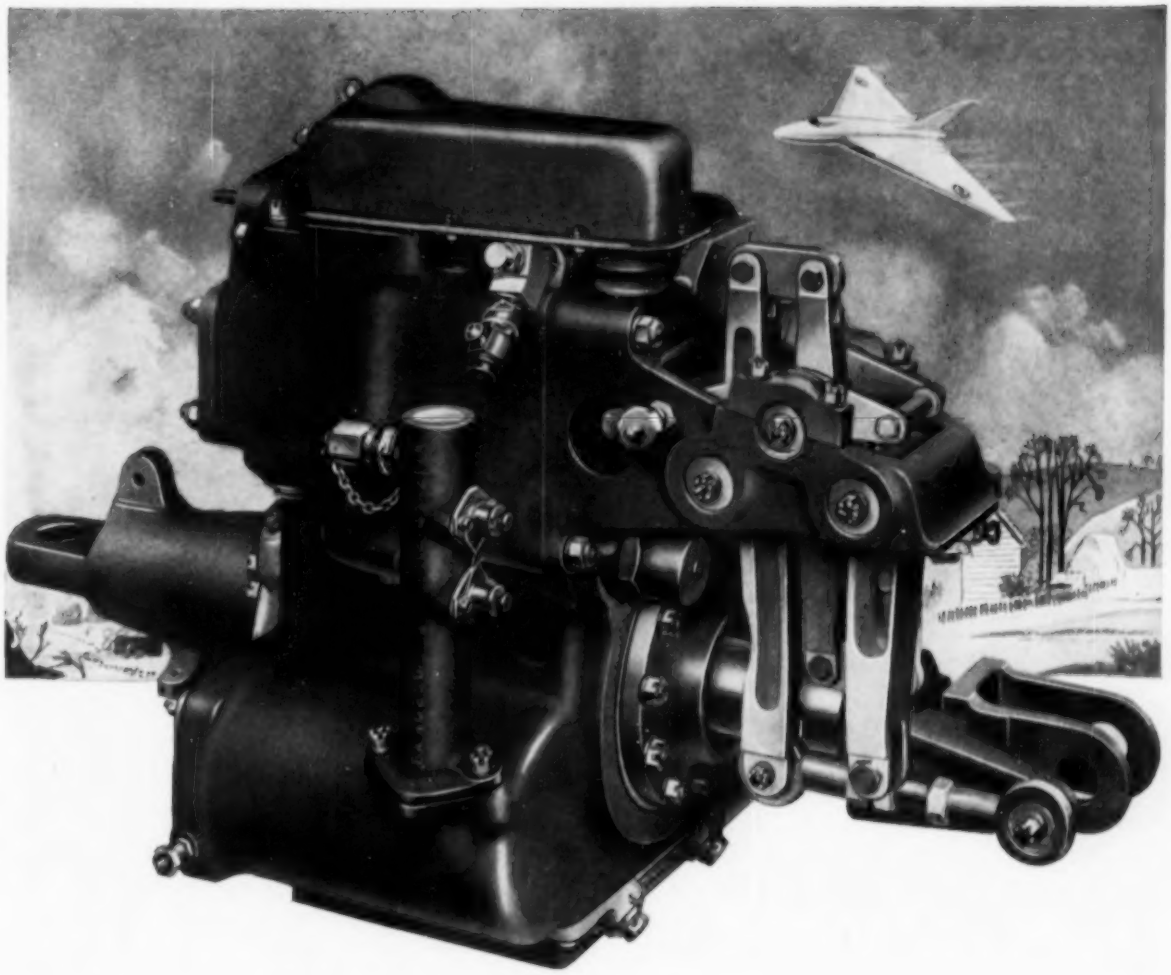

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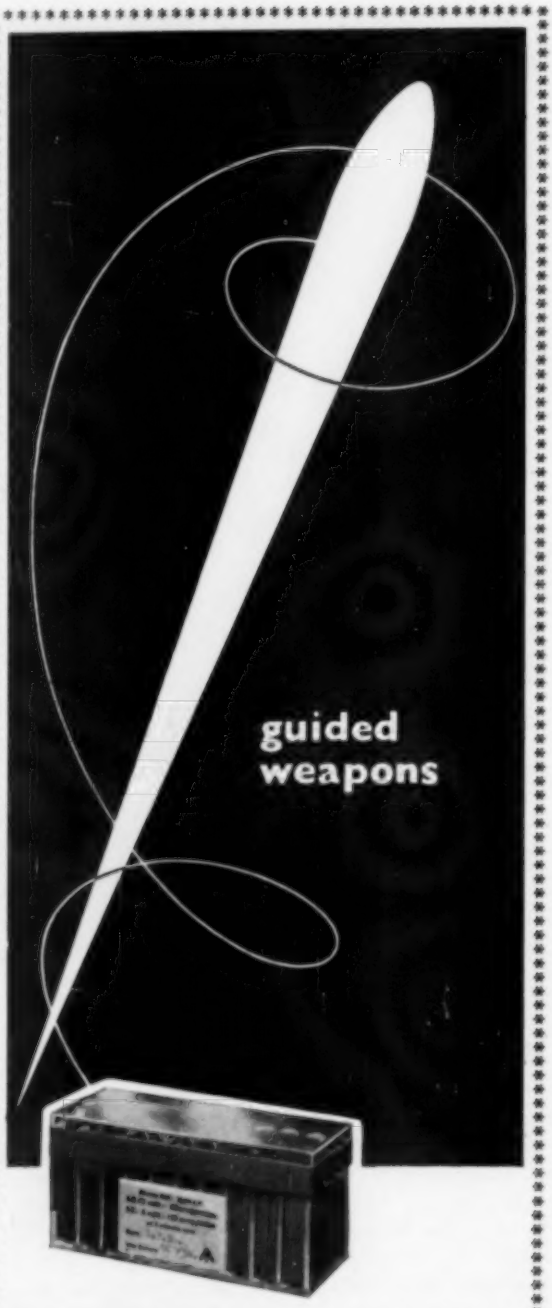

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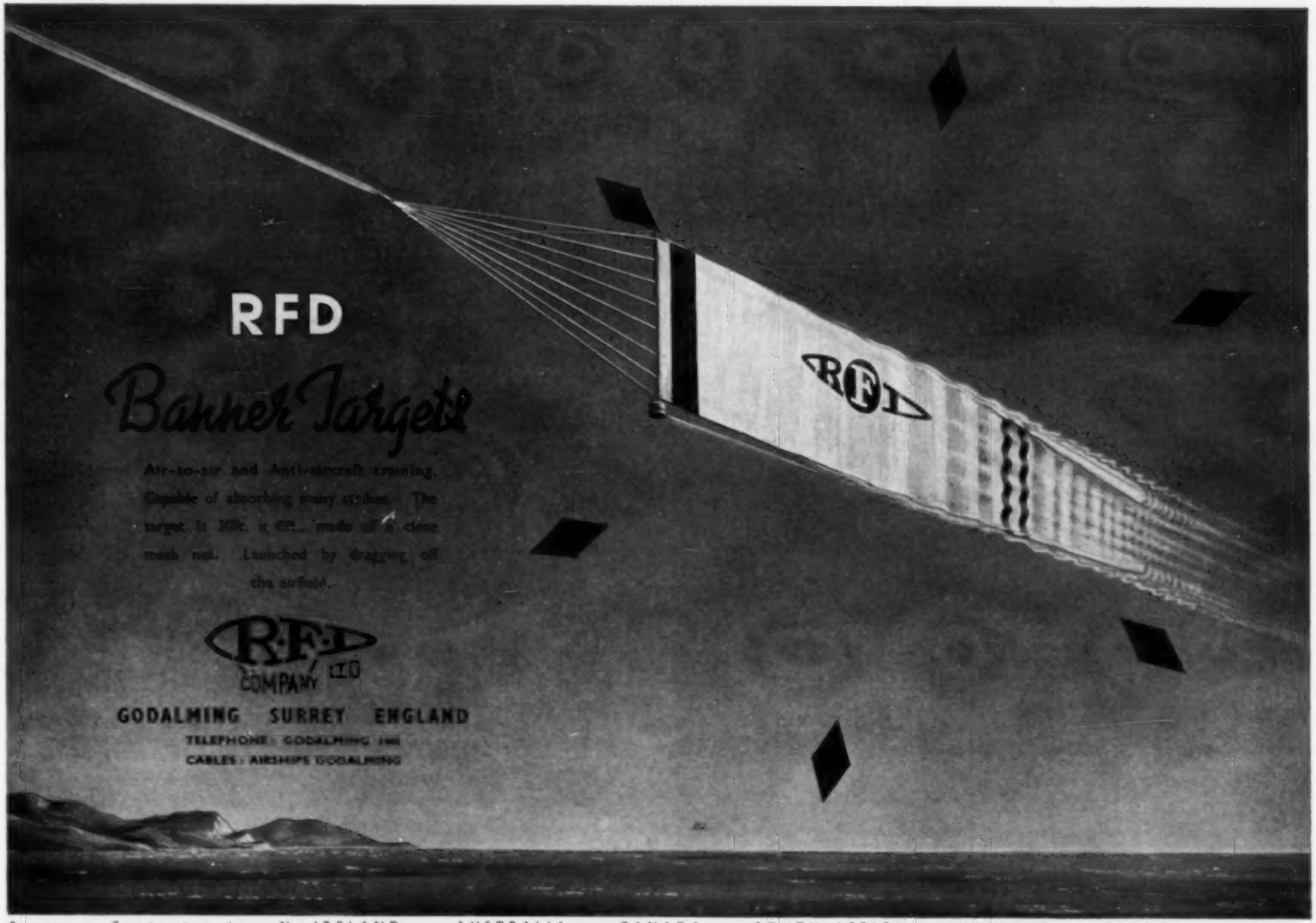
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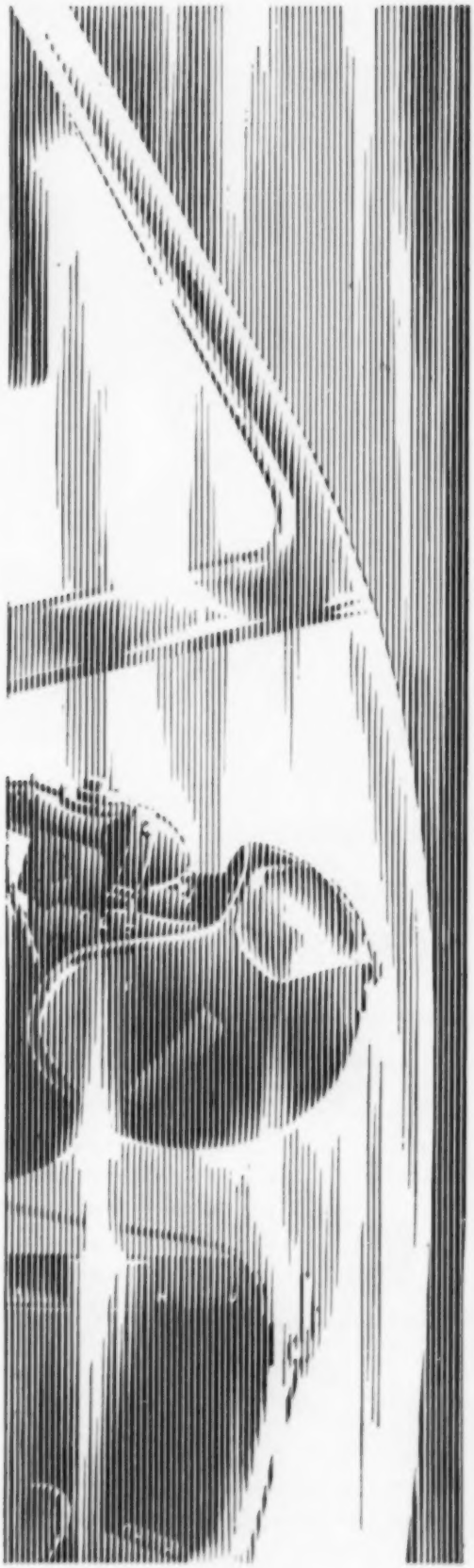

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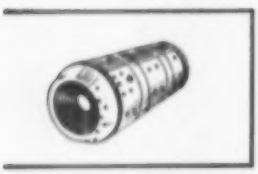

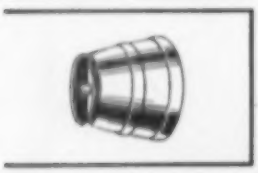

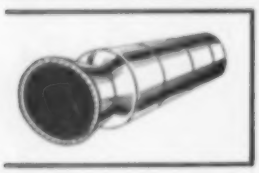

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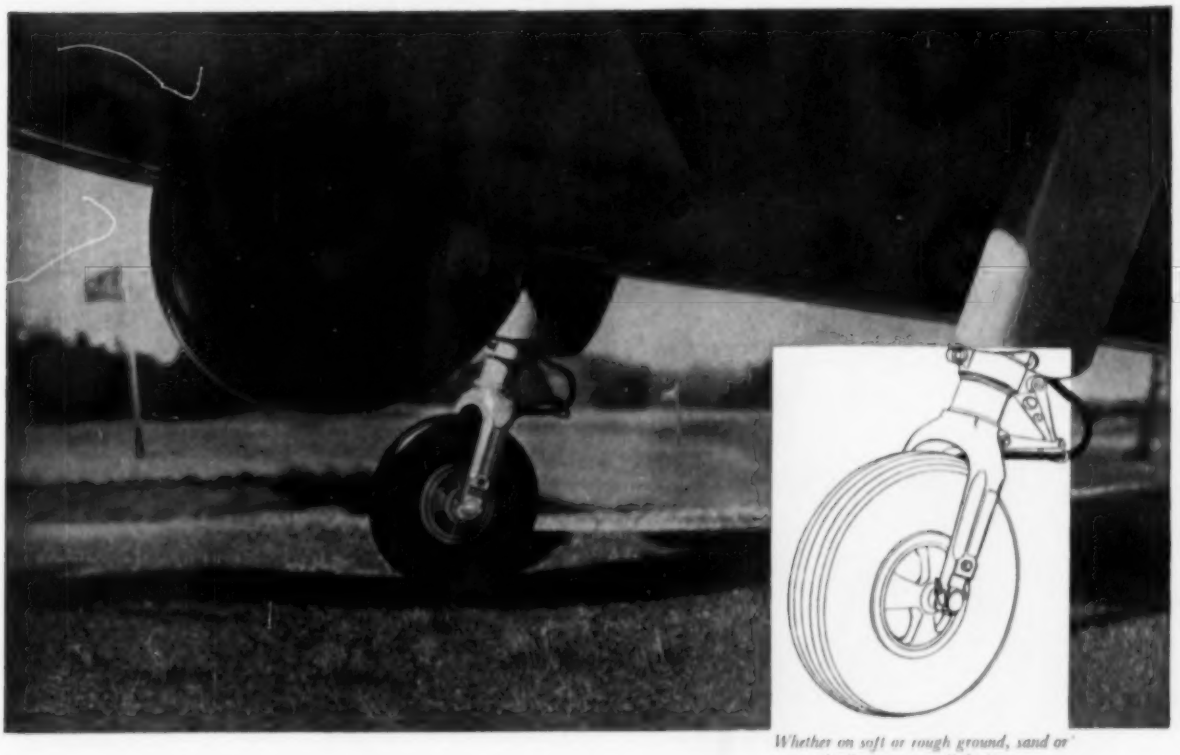
Golf course fairway — *Seamew* runway



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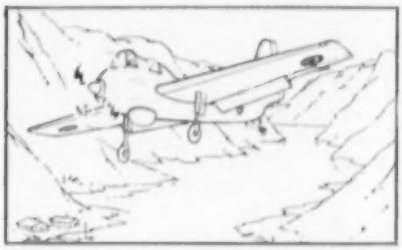
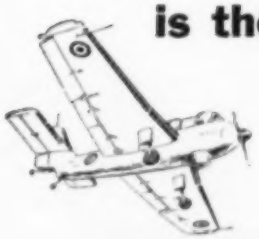
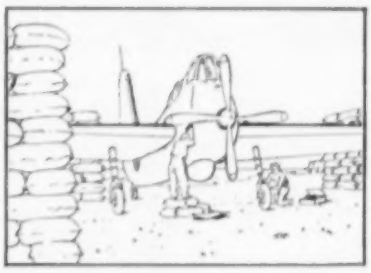


The extremely good handling characteristics of the Seamew combined with simplicity of construction and clear vision make it an excellent aircraft to fly, even for pilots with little experience of this type.

The *Short* answer is the *Seamew*



Economy of manufacture is paralleled by economy of maintenance, in terms of man-hours and spare components.



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Founded 1909

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EDITOR
MAURICE A. SMITH, D.F.C.
and Bar

ASSISTANT EDITOR
H. F. KING, M.B.E.

ART EDITOR
JOHN YOXALL

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Rational Security

IN a democratic country there can be no such thing as absolute secrecy about military matters. There are no peace-time laws or methods adequate for enforcing such security, nor would any be welcomed. Any attempt in this country to withhold all information which could possibly benefit hostile nations would first entail a "re-education" of the people; and (assuming any such totalitarian measure to be workable) it would inevitably kill public interest in matters of defence. Additionally, it would prevent interchange of much scientific knowledge, and it would also severely handicap commercial procedures—publicity and the like—essential for the health of industry. And the results would still be negligible, because there would be no control over the people of other nations with whom we were allied or had agreements, and with whom our "secrets," commercial and military, would have to be shared. Little can be achieved beyond making it difficult and costly for an enemy to obtain important specific information about military planning and material in time to make real use of it; and by "specific information" we do not mean superficial knowledge about existing aircraft—for example, of the type we waste much time vainly trying to withhold today.

The description "watertight" is frequently, if optimistically, applied to security. Certainly we may regard the pool of knowledge as being contained in a sponge. The fingers of security are pressed into a few of the larger holes, while tit-bits of information trickle and seep out everywhere else—and a number of the fingers in the round holes are, in our opinion, unnecessarily square.

There are few decisions calling for more knowledge of the subject, or for better judgment, than those concerned with security. Unnecessarily to suppress information about this or that product may seriously affect the prosperity of the firms concerned, and ultimately that of the industry of which they are members. Suppression may lead to duplication of effort and expense, and it may seriously handicap manufacturers in their efforts to sell goods abroad.

We have been told recently of one ridiculous example (outside the aircraft industry) in which the law requires certain information to be made public while the provisions of the security regulations forbids such a disclosure.

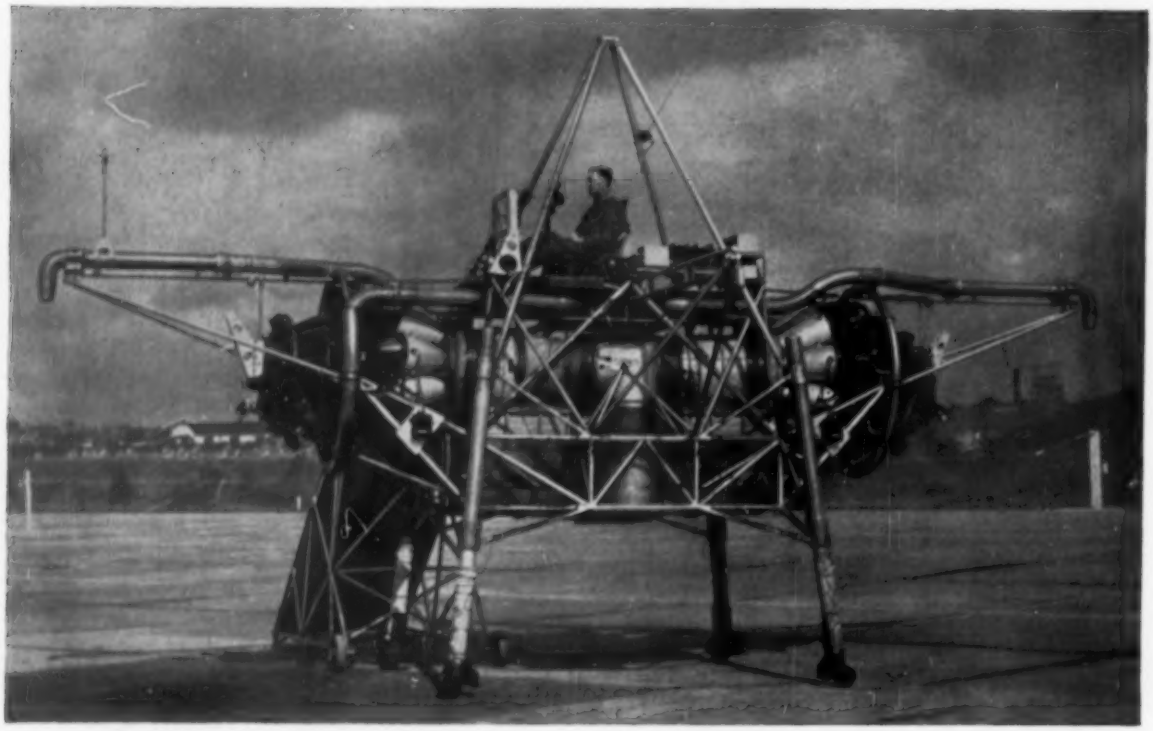
Recently, three lectures to be given before the British Interplanetary Society were completely suppressed on security grounds. As a result, we understand, the same lecture subjects are now likely to be dealt with by foreign scientists with whom for some time there has been an interchange of knowledge on the subject-matter concerned.

During the last few years, minor and relatively unimportant but nevertheless unauthorized disclosures have increased slowly but surely in number. On occasions, companies faced with intolerable restrictions according to the letter of the agreements on security (for the "law" is unwritten) have been led to countenance leakages of restricted information as commercial considerations required.

Occasionally, the opposite has occurred; information classified as secret, and which companies or Service departments would have preferred to withhold, has been publicly revealed by men in high places as an aid, perhaps, to illustrating a particular point in a debate or report. If this sort of thing does nothing worse, it certainly results in the security agreements being held in even less respect by others.

It is our opinion that the only practical course is to keep to the very minimum the subjects to which security regulations are to be applied, and then to insist on their strict observance. At the same time, selection and revisions should be the responsibility of men with authority and with technical knowledge, otherwise the natural reaction will be to play safe and veil everything—much as is the case with guided missiles today. Such action is not only unnecessary, but is unfair to the companies and individuals concerned, and far from encouraging to the taxpayers who are meeting the enormous bills for their defence. Seeing and hearing no results, the public fear that no progress is being made. Unfortunately, security regulations can be misused to cover up inefficiency.

Finally, some workable agreement will have to be reached with foreign countries with whom, as we have already stated, it is necessary to share military secrets and details of commercial products which inevitably overlap with military counterparts.



METALSOME STEED: The most intimate portrait to date of Rolls-Royce's twin-Nene V.T.O. test-bedstead (Capt. R. T. Shepherd up), subject of a news item below.

FROM ALL QUARTERS

Operation Snowdrop

WHAT was probably the largest R.A.F. and Naval operation ever organized to deal with a civil emergency took place last week, after the north of Scotland had received the full fury of the mid-month blizzard. Many communities had been isolated for several days; supplies of food and cattle fodder were running out; and at times telephone and power lines were out of action.

As soon as the gravity of the situation was realized the two Services combined with police and other civil authorities to stage what was appropriately called Operation Snowdrop. Under the direction of Cdr. D. G. Parker, R.N., and the Chief Constable of Caithness, a rescue co-ordination centre was established at Wick, and the light fleet carrier *Glory*, 13,190 tons, hurriedly dispatched from the Clyde to Loch Erribol, served as a base for six Naval helicopters, S-51s and S-55s. In the first few days these machines took some 3,300 lb of food to isolated villages and crofts and brought several sick people to hospital. Meanwhile, Sea Hawks from Lossiemouth carried out sweeps over the stricken area, looking for appeals for help in the form of letters imprinted in the snow—"F" for food, "C" for cattle fodder and "D" for doctor. They pinpointed seven such signals. Two more helicopters also left Lossiemouth to join those already at Wick. (Pictures, p. 102.)

R.A.F. relief operations were centred at Kinloss, whence Neptunes, Ansons, Oxfords and Varsities flew out to drop supplies to those who signalled for them.

By January 20th the situation was well under control. *Glory* held enough food "to feed a city for a month"; all calls for help had been answered and the airlift programme for the following days was in hand. Relief flights continued at high pressure, the number of sorties and the quantities of supplies dropped being increased. Helicopters proved their versatility in such operations as carrying a shepherd over the snowdrifts to two of his sheep and then bringing all three straight back to the homestead. B.E.A. aircraft on scheduled services turned aside to circle small islands and look for distress signals. On board *Glory*, meanwhile, bread was still being baked and food parcels made up for helicopter delivery, and stocks of tinned food and cigarettes, given by the United States Care Organization in Glasgow, were flown to Kinloss. An English cigarette manufacturer also contributed 6,000 cigarettes. Offers of help began to arrive from abroad, particularly Norway and Sweden.

The situation, however, was well in hand; a thaw set in on January 21st and conditions began to improve steadily; but Naval helicopters from Wick and R.A.F. aircraft from Kinloss kept up their supply delivery flights, particularly dropping bales of fodder and the ingredients of pig food. The aircraft carrier *Glory* left Loch Erribol to return to Glasgow on January 22nd, her task being complete. Captain Cameron of B.E.A.'s helicopter unit set out for Wick in an S-55 to assist in relief operations, but by the week-end the number of sorties had begun to decrease except for the dropping of food for animals still out in deep snow. A small force of helicopters, however, was kept standing by for rescue work should serious flooding occur as the snows melted.

The Rolls-Royce V.T.O.

RELEASED towards the end of this week was a film showing development flying in progress with the Rolls-Royce vertical take-off vehicle, powered by two Rolls-Royce Nene turbojets. On the same occasion it was specifically stated that techniques are being developed in Britain to enable aircraft to take off vertically from the normal horizontal position, as distinct from the vertical position associated with current American experiments. It was also disclosed that the weight of the V.T.O. vehicle is about 3½ tons and that the special control system was developed by the R.A.E., Farnborough.

Rolls-Royce remark that a great deal of development work remains to be done—for example, the problems of heat, noise, safety and the design of the most efficient engines and airframe have all to be tackled.

The spotting fraternity will note with sorrow the absence of any form of identification marking. This is explained by the fact that, as there is virtually nowhere to place it, special dispensation was obtained for the machine to perform anonymously.

Recognition Contest Winners

FIFTY-NINE teams—including entries from the U.S. Army and the Royal Netherlands Air Force Recognition School—took part in last Saturday's All-England Contest organized by the Aircraft Recognition Society and held at the Royal Institution in London. For the second year in succession the premier award, the Silver Hurricane trophy, was won by Post C/4, Group 5 (St. Albans), Royal Observer Corps. Their team members were Obs. D. S. Skeggs (captain), Obs. N. Price, and Obs. P. Wallace, who secured 87 marks out of a possible 105. Plymouth Aircraft Recognition Society, with 85 points, were the runners-up. The Handley

Page Silver Heracles trophy, awarded to the top A.T.C. team, was won by No. 220 (St. Albans) Sqn., A.T.C.—Cadets N. Vince, M. Barnes and C. Starling; runners-up were No. 285 (Coulsdon and Purley) Sqn., A.T.C.

The B.E.A. Viking Trophy, awarded to the best Services team, was won by F/O.s Ling, Williamson and Clack, from R.A.F. Station St. Eval.

S/L. Frank Murphy, Hawker's chief production test pilot, acted as independent umpire, and the trophies were presented by Mr. Peter Masefield, president of the Society.

Fairey Executive Appointments

IN step with the expanding activities of the Fairey Aviation group of companies, changes are being made in the top-executive organization. It is announced that Mr. G. W. Hall, A.F.R.Ae.S., is appointed an assistant managing director in addition to Mr. L. Massey Hilton, D.F.C., A.F.C., A.F.R.Ae.S., who has held that position since December 1951.

By the new arrangement, the duties of the two assistant managing directors, in each case under the chairman and managing director, Sir Richard Fairey, M.B.E., Hon.F.R.Ae.S., will be divided broadly as follows: Mr. Hilton will primarily be concerned with group organization and policy as a whole and, at top level, with sales and liaison, while Mr. Hall will be in general charge of the executive and administrative organization.

After many years of marine-aircraft flying in the R.N.A.S. and R.A.F. with experimental types and on aircraft carriers, Mr. Hilton retired from the R.A.F. in 1931 in order to join the company. He was appointed a director in 1934, was technical director during 1940 and 1941, and has been assistant managing director since December 1951.

Mr. Hall served his apprenticeship with the Fairey company, learned to fly in 1926, and joined the Rolls-Royce aero-engine experimental staff, where he was closely connected with the development of Schneider Trophy engines. Rejoining Faireys in 1932, he was engaged on engine and airscrew development, engine installation and oil-cooling research. He was appointed successively flight development engineer; assistant chief engineer; chief development engineer; chief research engineer; manager of research and armament development division; and engineering director. He has also learned to fly helicopters, going solo in a Sikorsky R-4.

Mr. L. Massey Hilton

Mr. G. W. Hall

London Air Law Lectureship

AT the invitation of Mr. John Boyd-Carpenter, Minister of Transport and Civil Aviation, the London School of Economics has established a lectureship in air law. It is to be for a period of three years; consideration will then be given to the possibility of continuing it or of establishing a readership or chair of air law. The London School of Economics has appointed Mr. F. P. Neill, B.A., B.C.L. (Oxon) to the post.

The new move follows discussions initiated by the M.T.C.A., in which representatives of Government departments, universities, the airways Corporations, the independent operators, the aircraft industry and the legal profession took part. The arrangement would not, however, have been possible, says the M.T.C.A., without the generous financial support of the S.B.A.C., the Corporations, the British Independent Air Transport Association and the London School of Economics.

The establishment of the lectureship will be marked by a public lecture on *The Importance and Interest of the Study of Air Law*, to be given at the London School of Economics by Mr. Christopher Shawcross, Q.C., on February 8th, at 5 p.m. Mr. Boyd-Carpenter will preside.

R.A.F. Gliding Progress

AT least three R.A.F. teams, apart from those of 2nd T.A.F., will be entered for this year's National Gliding Championships at Lasham. The Service clubs concerned are those at Little Rissington, Scampton (both of which are expected to enter Olympias) and Boscombe Down (probably a Kranich in the two-seater class).

This announcement was made at the annual meeting of the R.A.F. Gliding and Soaring Association in London on Friday last. Over a hundred members were present, and heard it reported that 9,493 U.K. launches had been made during the 12 months ending November 30th, 1954, an increase of some 2,000 over the previous year. In addition, over 15,000 launches had been logged by 2nd T.A.F. clubs. Average active membership during the year had been 500, and the highest individual club total of launches was the 2,308 achieved by St. Athan. The R.A.F.G.S.A. clubs in Britain and Germany had together flown 1,786 hours. Twelve of the recently established gliding scholarships (whereby Service personnel may receive financial assistance in gliding at civilian clubs) had been awarded.

The committee of the Association, re-elected at the meeting, consists of A.Cdre G. J. C. Paul, D.F.C. (chairman), W/C. W. H. Ingle, A.F.C. (deputy chairman), W/C. F. R. Jeffs (secretary), W/C. N. W. Kearon (equipment member), F/L. R. Farmer (treasurer), S/L. C. G. Matthews (technical member) and S/L. H. Neubroch (air member). For 1955, the Association's targets are 15,000 launches and 750 members, plus a successful effort in the Nationals.

The Pioneer Spirit

"I HAD thought that after all these years there could be nothing new in fixed-wing flying, but in my opinion the R.A.F. in Malaya is not only making aviation history, but has created and proved an application of flying which could convert the mystery and the menace of jungle territories into something of inestimable benefit to mankind."

These were the words of Mr. D. F. McIntyre, managing director of Scottish Aviation, Ltd., on his return to Scotland from a two-week visit to Malaya. He reported that 150/200-yd landing strips for the R.A.F.'s Prestwick Pioneers were being steadily constructed all over the jungle-covered mountains of Malaya. "It is a typically British type of operation," he added, "based on wise and far-seeing military and civil decisions. Understanding, the hand of friendship, daily contact and help are being offered to the aborigine population through these jungle airstrips and garrisons, as an alternative to indiscriminate bombing and harrying of terrorists, which in jungle country has in the main proved ineffective and tends to make more enemies than friends." Before visiting Malaya he had been under the impression that there would be "some kind of reasonable approach" in and out of the jungle airstrips, but he was astonished to find that in many cases there was a strip only, and that a technique of flying had been developed which reduced the need for a normal approach to almost nil. The R.A.F. had made it a safe, everyday operation.

STRATOPROPJET: After several years of gestation, the Boeing XB-47D has now emerged, and is shown during taxying trials at Boeing Field, Seattle. In place of the original twin-J47 turbojet pods, a pair of Wright T49-W-1 turboprops are installed, driving large four-blade airscrews with ducted spinners. The T.49 is an 8,000/9,000 h.p. unit based upon the Sapphire; the XB-47D will serve as its flight-test bed.

CHOICE OF TURBOPROPS

A Preliminary Appraisal of Three Very Efficient British Power Units

WHATEVER causes there may be for uneasiness in the British aeronautical scene as a whole, the industry and its customers can derive solid satisfaction from the achievements of our engine manufacturers. Our prowess in this field is no flash in the pan, neither is it founded on one engine or company. Such firms as Armstrong Siddeley, Bristol, de Havilland and Rolls-Royce have consistently produced gas turbines of the first quality during a dozen competitive years. They have now been joined by Napier and Blackburn and form an unmatched source of all types of modern gas turbine aero engine.

The three units, the Bristol BE.25, the Napier Eland and the Rolls-Royce R.B.109—all turboprops for transport aircraft—with which this account is concerned are, in spite of increasing "know-how" and effort abroad, likely to place our engine industry in an even stronger position in the years to come. Apart from the Eland, which has been fully described, these engines are still in a very early stage of development, and very little specific information has been issued about them by their manufacturers, Bristol and Rolls-Royce.

Nevertheless, over a period of weeks—and particularly from foreign sources—it has been possible to gather together quite a lot of information and data about these two later units. The drawings presented here are also of a provisional nature, having been based upon previously published outlines, and in the case of the Rolls-Royce R.B.109, an examination of a mock-up.

Certain comments are applicable to all three engines. Each is descended from, but bears little resemblance to, an earlier turboprop of comparable size but very much lower output and efficiency. The new units can, therefore, take advantage of many years of painstaking research; and, although they are very much more advanced than their predecessors, it is likely that—such is the improved understanding of such things as seals, combustion systems, gear teeth, bearings, and the like—their development will prove to be surer and certainly no slower than has been customary in the past.

Each of the new engines employs a direct ram intake, the diameter of which has clearly been determined by the minimum size of spinner for an airscrew hub capable of transmitting the power—and quite a large spinner it is seen to be. The air is drawn in around the full periphery of the spinner and then passes down a tapering intake duct surrounding the reduction gear before passing to the axial compressor.

Each of the new compressors is remarkably small in relation to the output of the engine—an indication of high efficiency and also of fairly high rotational speed. In the basic design of a turboprop one has to strike a balance between optimum r.p.m. for both the engine and airscrew: if the engine is designed to run at a slow speed, the size of the compressor/turbine assembly becomes excessive, while too high a rotational speed brings trouble in the design of the reduction gearing. The Eland is known to have a singularly efficient single-stage reduction gear.

All other things being equal, a high pressure-ratio results in a high overall efficiency. Unfortunately, the characteristics of axial compressors are such that, the greater the pressure ratio, the greater the difficulty of achieving ease of handling and flexibility in operation. There are various ways of overcoming the tendency. The basic method is sheer sound design, so that the compressor operating line is as far as possible from the surge line (or, rather, *vice versa*). Another is to fit variable-incidence inlet guide-vanes and blow-off valves, to prevent stalling during starting. Another approach is to split the compressor into mechanically independent "spools" which automatically match themselves when the engine is running steadily. This last arrangement is used on the Bristol engine and is probably also a feature of the Rolls-Royce.

The three engines all have, or will have, automatic control systems to prevent damage to the engine through mishandling. The familiar Dart is now being fitted with a turbine-inlet temperature control (*Flight*, January 14th), and one might expect its successor to have a similar arrangement. The Eland has a very effective variable-datum control in which turbine-inlet temperature is governed by a mercury-vapour system. The new Bristol engine retains, in an advanced form, the electronic temperature-controller developed by Ultra and first used on the Proteus.

Each of the new engines is being developed as a complete power unit, with comprehensive accessories—many specially developed for the engine concerned. Another feature common to the trio is a bleeding-off point for compressed air suitable for a cabin-air system. In the case of the Rolls-Royce engine this air is extracted between the two compressors, a fact which may indicate an exceptionally high overall pressure ratio.

All three engines should cowl superbly, although it might at first be considered that, were it not for the large-diameter intake, a very much slimmer cowling would be possible. It may surprise some readers to find that, in fact, a comparatively bulbous cowling based on the intake diameter has a drag scarcely greater than that of a pencil-slim cowling similar to that of the Viscount. Furthermore, it offers considerable space for accessories without becoming inaccessible and without breaking the exterior profile.

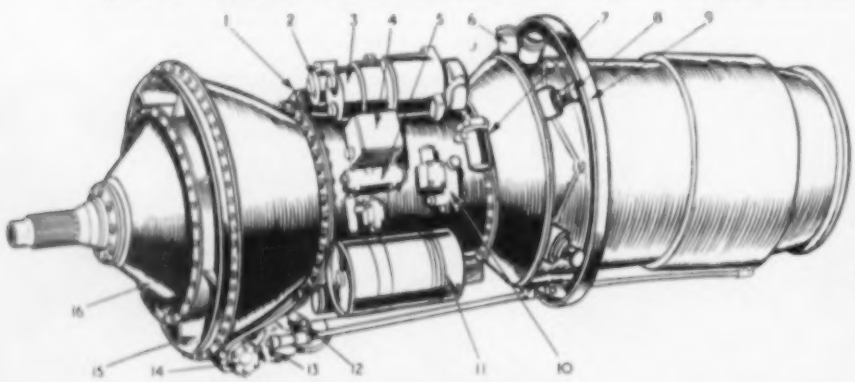
Bristol BE.25. Although this turboprop owes a very great deal to the Bristol engine division's work upon the Proteus and Olympus, it is a wholly new engine. In one very important respect it differs from every other gas turbine yet built: it is not a "full throttle" engine but, to employ piston-engine parlance, is "supercharged."

The general idea is that, although the engine is potentially capable of a sea-level output of something in excess of 7,000 h.p., it is throttled to a maximum of 4,000 s.h.p. This surprising procedure pays several dividends. It means that the 4,000 s.h.p. will always be available, even in the most adverse conditions of airfield altitude, temperature and humidity; this would permit unprecedented simplification of flight-planning for airliners and would also, of course, allow full payloads to be carried from high, tropical airfields. Again, a very high power will be available for cruising—possibly not much less than the maximum continuous power at sea level. Finally, and a point which is probably proving most useful to Bristols at the present time, the BE.25 can be fully developed without going to the truly immense trouble of designing and developing a reduction gear and airscrew system capable of accepting almost twice the power.

On the other hand, of course, it could be argued that the BE.25 will be larger than it need be for the s.h.p. which it provides.

There are two turbines, the high-pressure stage driving the h.p. (rear) compressor and the rear turbine (which has three stages) driving both the low-pressure (front) compressor and the reduction gear to the airscrew. This arrangement overcomes a shortcoming of the free-turbine turboprop. The power turbine of the latter type of engine tends to "run wild" and overspeed if it is taken off-load, such as might occur were the reduction gear to fail. The BE.25 power turbine also drives a compressor—the compressor doing most of the work, in fact—which forms a fool-proof safety device.

The combustion system of the BE.25 is described as being of "tubo-annular" form, with ten flame-tubes mounted in an annular casing. Fuel is supplied by a manifold surrounding the diffuser section of the engine, and the main fuel pump lies under the rear compressor case. Other features are shown in the drawing.

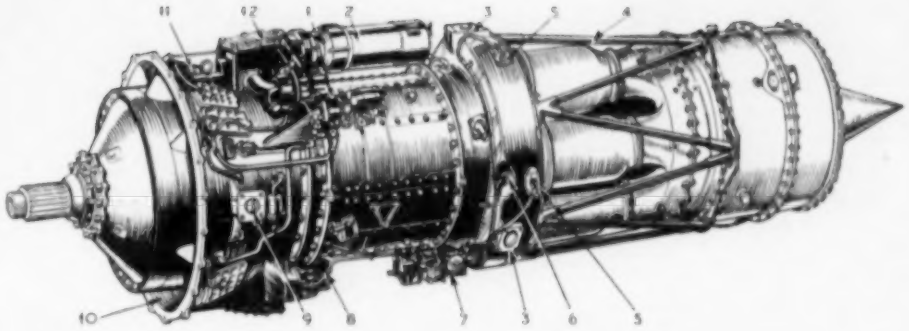


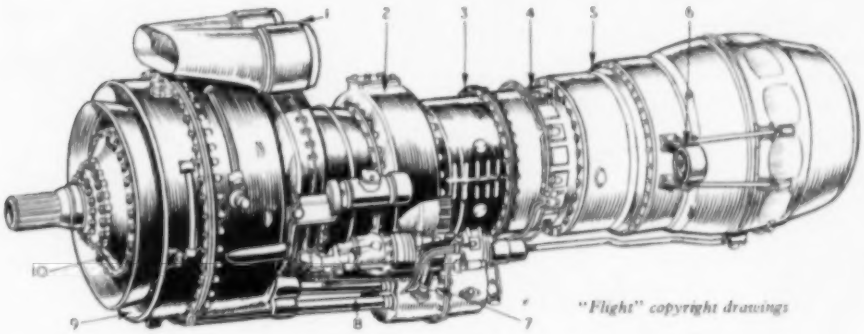
The Bristol BE.25 "supercharged turboprop," showing its wasp-waisted layout, which facilitates the installation of accessories.

1, Saddle oil tank to starboard; 2, electric starter; 3, 50-kVA alternator; 4, Ultra electronic control box; 5, starting pump; 6, main air bleeds; 7, fuel filter; 8, four dynamic suspension units; 9, mounting ring; 10, barometric pressure control, torque limiter and shut-off cock; 11, oil cooler (port and starboard) fed by pipe from individual ram intake; 12, oil-pressure transmitter; 13, oil pump; 14, scavenge filter; 15, main air intake; 16, airscrew reduction gear.

Of earlier conception than the other two engines, the Eland will be ready first, and will probably be less expensive. It has many attractive features.

1, Fuel pump; 2, electric starter; 3, mounting points; 4, tubular turbine-support; 5, fuel burners; 6, igniter plug; 7, fuel-metering unit; 8, oil pump; 9, test-bed mounting point; 10, main air intake; 11, anti-icing oil pad; 12, top accessory "banana plate."





"Flight" copyright drawings

The slim Rolls-Royce R.B.109, showing the disposition of the principal accessories beneath.

1, Twin oil-coolers mounted above oil tank; 2, compressor bleed face fed from annular duct; 3, end of rear compressor and beginning of steel section; 4, Duplex fuel gallery and 10 burners; 5, beginning of turbine section; 6, shock-absorbing mounting; 7, engine accessories; 8, accessory-drive shaft; 9, main air intake; 10, reduction gear and torquemeter housing.

The performance outlined in the data table assumes a number of very high levels of component efficiency, all of which have already been achieved in test running. So far the engine has not run as a complete unit, but it is scheduled to do so this year, and is expected to be available for commercial services within three years. The engine has already been linked both with the Britannia—in which it can be installed, as a retrospective modification if necessary, with a minimum of trouble—and also with a new, and much faster, Britannia successor.

BRISTOL BE.25.—Split-compressor-type turboprop, with low-pressure compressor and airscrew driven by three low-pressure turbine stages and high-pressure compressor driven by single high-pressure turbine. Overall diameter, 41.75in; length, 110.3in; dry weight (including oil tank and coolers, rigid mounting units and starter), 3,058 lb; take-off power, 4,000 s.h.p. or 5,750 e.h.p. at 10,500 r.p.m. (all r.p.m. figures refer to the 1-p. section) at all heights up to 5,000ft (tropical max.), 13,000ft (temperate max.) or 16,500ft (i.s.a.c.), typical maximum cruising rating, at 36,000ft and 350 kt under i.s.a. conditions, 1-p compressor 8,860 r.p.m., turbine entry temperature 1,000 deg K, h-p compressor r.p.m. 8,700, mass flow 25.8 lb/sec, total power 3,080 e.h.p., fuel flow 1,185 lb/hr, specific fuel consumption 0.508 lb/hr/s.h.p. or 0.385 lb/hr/e.h.p.

Napier Eland. Although it embodies several very advanced features, the Eland is of fundamentally simple conception. The compressor is a single 10-stage drum, providing a pressure ratio of 7:1, driven through a tubular shaft by a three-stage turbine. Starting and acceleration are facilitated by the turbine-temperature control already mentioned and also by a row of variable-incidence inlet guide vanes.

From the compressor, the drive to the airscrew is transmitted by a central quill shaft, at the forward extension of which is a small spur gear supplying power to a self-centering reduction gear housed within a torquemeter of novel design. The quill shaft carries a bevel gear at each end, the gear at the compressor end driving the overspeed governor and most of the airframe accessories and the forward bevel driving the oil and torquemeter pumps. All the accessories are mounted on "banana plates" housing trains of spur gears, and no accessory protrudes outside the confines of the 36in-diameter minimum-drag cowling.

The combustion system consists of six individual cans, each housing an upstream burner. External tubular struts support the turbine section from the main central mounting casting, and the whole engine is so designed that its four main assemblies—reduction gear, compressor, combustion chamber and turbine—can be removed and replaced individually. Each combustion chamber can also be dismantled without disturbing the rest of the engine.

The Eland first ran in August 1952. Two years later it began flight trials in a Varsity, and considerable flight-development plans are currently in hand (see page 125). A trial 150-hr type test was successfully run in December last, the engine stripping very well, and later developments are now being prepared which will raise the maximum power to 4,000/4,200 h.p., much of this increase being obtained by raising the turbine inlet temperature.

NAPIER ELAND (NE1.1 rating): single-shaft turboprop with 10-stage compressor, six combustion chambers and three-stage turbine. Overall diameter, 36in; length, 122½in; dry weight, 1,661 lb; maximum take-off power, 2,690 s.h.p. (3,007 e.h.p.) at 12,500 r.p.m.; typical maximum cruising rating, 30,000ft i.c.a.n. conditions at 400 m.p.h., 1,325 s.h.p. at 12,000 r.p.m. with s.f.c. of 0.566 lb/hr/s.h.p. or 1,570 e.h.p. with s.f.c. of 0.478 lb/hr/e.h.p.

Rolls-Royce R.B.109. Behind the design of this engine lies experience of more turboprop hours—certainly flying hours—than any other in the world. Of advanced conception, it will probably be smaller and lighter than other engines of equivalent power, yet should quickly qualify for a long overhaul period.

It has been suggested that, following the company's previous practice, the R.B.109 may well make use of components of the same aerodynamic form as those used in other Rolls-Royce engines, scaled down to suit the much lower mass flow of the turboprop. The diameter of the compressor rotor cannot be much more than 20 in, and the r.p.m. are therefore probably not much less than that of the Dart. Both reduction gear and torquemeter seem to lie snugly within the conical space behind the spinner, the intake being of a particularly conical form. An annular oil tank is attached directly behind the intake casting; the twin oil coolers lie on top of the engine, where they would be fed with air from an individual lip intake, as in the case of the Dart.

No information has been released about the interior of the 109, but it may be noted that the combustion system is notably short, compact and Avon-like, and that there is a pronounced increase in diameter at what is clearly a multi-stage turbine. More than most engines, the R.B.109 seems to consist of a number of self-contained assemblies bolted together around their mutual peripheries. Again unlike some of its contemporaries, it does not appear to be mounted by a ring of shock-absorbers around the centre-section, but adheres to the more well-established formula of at least four supports, two being prominent in line with the turbine nozzle guide vanes. The accessory grouping might indicate that the first application of the engine will be in a machine with a high wing, for everything seems to be accessible from underneath, the sides and top being relatively devoid of excrescences.

To judge by the mock-up exhibited at Derby recently, light-alloy is used for all the principal structural parts right back to the combustion chamber—a surprising fact, bearing in mind the degree of compression which must be attained, and one which should result in the engine being much lighter than the Bristol turboprop with which it is contemporary (although the latter will have a considerably higher cruising power at altitude). The BE.25 also has a higher residual jet thrust, so that when both it and the R.B.109 are run at equal shaft powers the Bristol gives a higher equivalent power—which becomes more marked as flight speed is increased. Nevertheless, the Rolls-Royce engine will be able to take a considerably smaller cowling.

A great deal of component running on the R.B.109 has already been completed, and a complete unit is now about to start running on the test bed. It falls, therefore, into the same time scale as does the BE.25. It already has a number of firm or projected applications, one of the more unusual being for a Douglas helicopter for commercial transport duties.

ROLLS-ROYCE R.B.109.—Axial turboprop, apparently with an annular combustion system and multi-stage turbine. Diameter, about 32in; length, about 115in; dry weight, 2,000/2,500lb; maximum take-off power, 4,000 s.h.p. plus 1,000 lb thrust, or about 4,350 e.h.p., with a mass flow of about 40 lb/sec; typical cruising power, not released, but possibly a maximum cruising rating of 2,500 e.h.p. at 25,000ft would be established.

D FOR DOCTOR, marked on the snow, brings a Naval S-55 Whirlwind to collect a hospital case from a Sutherlandshire village. On the right is a scene of activity at Wick Airport, with an S-51 Dragonfly returning from a sortie. (See "Operation Snowdrop," page 98).

HERE AND THERE

Communist Equipment

AN assortment of Russian-built aircraft was used by the Chinese Communists in raids on Yi Kiang Shan last week. In one attack, according to the official Nationalist communique, there were 23 La-11s, 29 Tu-2s, four Mig-15s and four Il-10s.

Gnat Fleet Fighters ?

CLOSE interest is being shown by the Royal Canadian Navy in a possible carrier-borne version of the Folland Gnat light fighter. Cdr. H. J. Hunter of that Service has been in England flying the Midge, low-powered prototype of the Gnat.

The Paris Salon

THE 21st International Aeronautical Salon, to be held at Le Bourget from June 10th-19th, will feature a different aspect of flying each day. For example, on the 15th the public will see the arrival of private aircraft which will participate in the great international rally being staged under the auspices of the F.A.I. Altogether the Salon promises to be one of unusual interest and importance. Three special issues of *Flight*—"Paris Show Guide" (June 17th), "Paris Show Report" (June 24th), and "Paris Show Review" (July 1st)—will mark the occasion.

SATISFACTION ALL ROUND—doubtless over further encouraging progress by the Olympus—is registered during a visit by Air Chief Marshal Sir John W. Baker (Controller of Aircraft, M.o.S.) to the Bristol Aeroplane Company's engine division. Bristol executives are (left) Dr. S. G. Hooker and (at right) A. Cdre. F. R. Banks and Sir Reginald Verdon Smith.

Hunter F.4 and F.5

POWERED respectively with the Rolls-Royce Avon and Armstrong Siddeley Sapphire, these Hunter variants are developments of the Mks 1 and 2, having increased fuel capacity.

Magnesium Shooting Star

THE first flight of an experimental all-magnesium version of the Lockheed F-80C Shooting Star should take place next month at Mitchell Air Force Base, New York. The airframe has been built by East Coast Aeronautics, Inc., under contract to the Air Research and Development Command. It is the second of two such machines for which a contract was placed in 1949; the first has successfully undergone static tests.

The Rising Sun

THE first consignment of 59 aircraft, under the Mutual Defence Assistance Programme, was received by the Japanese Defence Force at Tachikawa airfield on January 20th. It was made up of 35 T-6 (Harvard) trainers, 16 C-46 Commando transports, and eight Lockheed T-33 jet trainers. All the aircraft bore the insignia of the Rising Sun. The Japanese Defence Board is said to be expecting delivery before April of about 400 aircraft in all, including 70 North American Sabres. Five Japanese pilots are already training on T-33s.

About a Motoring Classic

TODAY'S (January 28th) issue of the *Autocar* contains a complete illustrated description of the Monte Carlo Rally.

Australian Minister's Visit

DUE to arrive at London Airport last Tuesday was the Australian Minister for Air and Civil Aviation, Mr. A. G. Townley. His visit is principally to accompany the Australian Prime Minister, who was arriving a day or two later for the Commonwealth premiers' conference, but it is expected that he will see something of the British aircraft industry.

Drawing-board to Keyboard

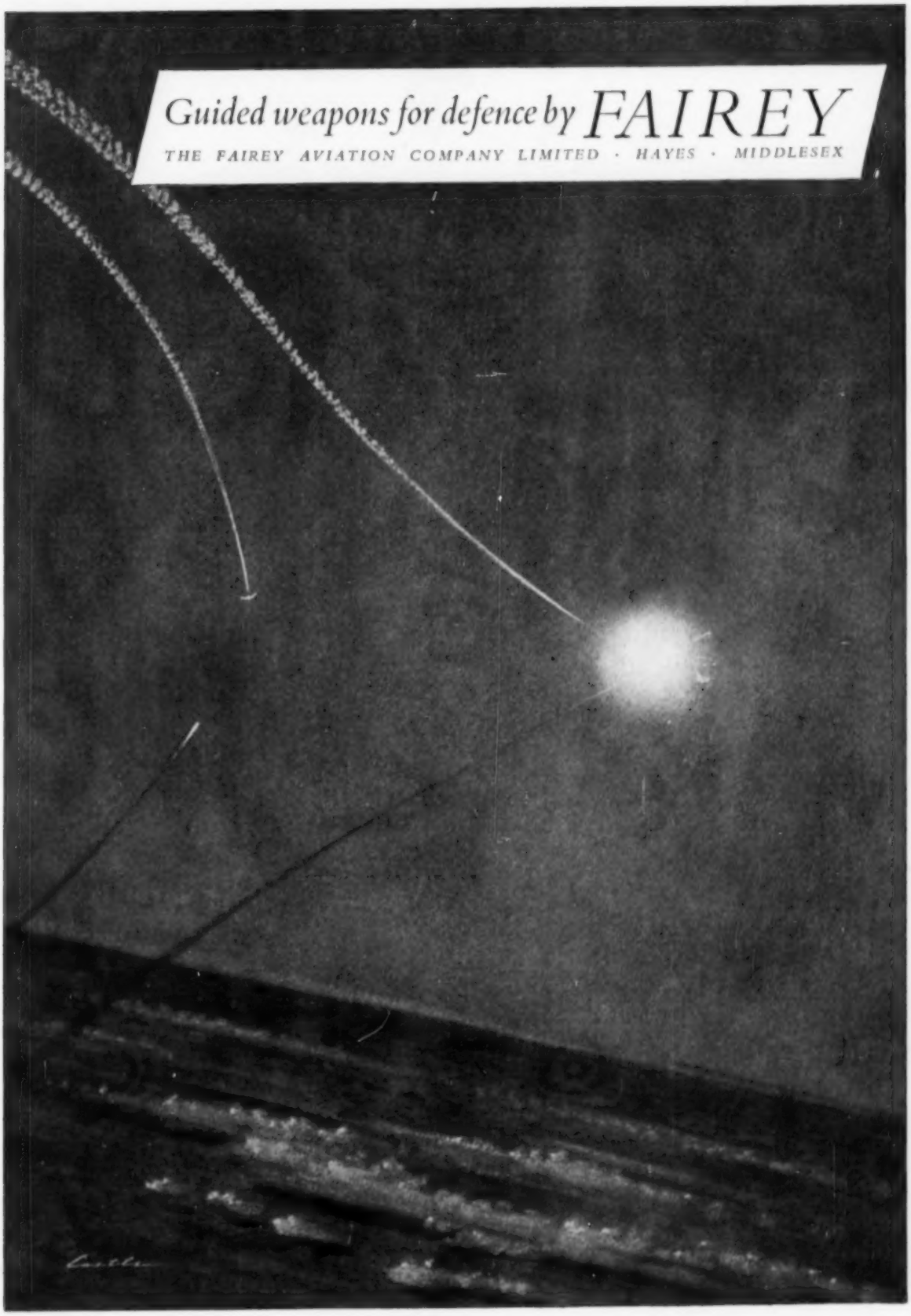
AN engineering draughtsman, Mr. Peter Webb, A.R.C.M., who is also an accomplished pianist, has been selected as one of the eight representatives of Great Britain to compete at the Fifth International Chopin Festival in Warsaw next month. His return fare will be about £78, and his colleagues in the drawing office of Aviation and Engineering Projects, Hounslow, have been contributing weekly to help him raise the money.

Robert B. Hotz's New Post

THE new Editor of the American journal *Aviation Week*, in succession to Robert H. Wood, who has resigned, is Robert B. Hotz, since 1952 executive editor, with headquarters in Washington. Mr. Hotz, who joined McGraw-Hill in 1946, and *Aviation Week* when it was founded in 1947, served in the U.S. Air Force during the war and was awarded the Air Medal with Oak Leaf Cluster. In his new appointment he will work in New York.

Gloster Research

DUE to the increasing demands placed upon it, the Research Department of the Gloster Aircraft Company is being reorganized and expanded, and will shortly be rehoused in vastly larger buildings. This was disclosed by Mr. E. W. Shambrook, director and secretary of the company, at the Department's annual dinner in Gloucester recently. Mr. Shambrook paid tribute to the confidence displayed by the Americans in the Javelin, and referred to evaluation trials now in progress.


Guided weapons for defence by FAIREY
THE FAIREY AVIATION COMPANY LIMITED · HAYES · MIDDLESEX

The Commonwealth CA-27 "SABRE" uses Nimonic* Alloys

This Australian-built version of the battle-proved North American Sabre aircraft first flew in August, 1953, and production is now proceeding. Modifications to the original F.86 Sabre include the provision of 30 mm. Aden guns in place of the ·5 inch weapons previously fitted, and the adoption of the Commonwealth Aircraft Rolls-Royce Avon. The installation of this engine has resulted in a 50 per cent increase in power, yet this engine is considerably lighter than the original power plant.

The Avon installed is similar to the British Rolls-Royce Avon RA.7, and like the British engine employs Nimonic Alloys in its construction.

The Nimonic Series of heat-resisting alloys are used for the rotor blades of every British aircraft gas turbine in production.

These alloys are being increasingly used in industry where resistance to creep, fatigue and high-temperature oxidation is required.

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PRODUCTION CONFERENCE

Extracts from Papers Recently Presented in Southampton

PART I

AS briefly recorded in our last issue, the Southern Section of the Institution of Production Engineers held their third annual conference on problems of aircraft production at the University of Southampton on January 14th and 15th. On this and the following page, we publish slightly abbreviated versions of two of the less specialized papers presented at the conference; in our next issue we will give a full account of the remaining three papers and the ensuing discussions.

CHOOSING as his subject *Aircraft Design Problems and Trends*, the author of the first paper was Mr. A. E. Woodward-Nutt, M.A., F.R.Ae.S., Principal Director of Research and Development (Aircraft) Ministry of Supply. He began by stating that, in so far as the theme of the 1955 conference was concerned (integral construction contrasted with conventional methods), he was not going to come down heavily in favour of either method. On the other hand, he noted the recent general trend towards greater integration in aircraft construction, and he felt that this trend must continue to some extent—in much the same way as must the trend for greater integration between the aircraft itself and its equipment. The difficult part was to decide how far it should go.

He went on: "In looking at problems of this kind, I find frequently a tendency to ask what is being done in the U.S.A. and to conclude that anything done there must be right. This is a conclusion with which I heartily disagree." Mr. Woodward-Nutt was by no means of the opinion that we had nothing to learn from American engineers, but he stressed the fact that not only were their problems often quite different from our own, but that the resources which they could bring to bear on them were also vastly different. He showed a figure comparing the expenditure on military aircraft in the U.S.A. and U.K. over the last few years, commenting that—in contrast—the number of major aircraft manufacturers was approximately the same in each country.

He then outlined the manner in which constructional methods ha.⁴ progressed during the past 50 years and commented on the fact that most of today's aircraft were approximately 80 per cent aluminium alloy and that more than half of this was usually in sheet or strip form. He concluded that we had not, therefore, got very far in integration yet.

His next major section outlined the growth of complexity of aircraft and, although many of these figures have been published previously in *Flight*, we are reprinting this part of Mr. Woodward-Nutt's paper verbatim, since it provides a good overall picture of the manner in which aircraft have become more complicated.

"However you look at them, the military aircraft of today and of the immediate future are becoming large and highly complex pieces of machinery. This complexity is well reflected in their cost. At the start of the 1939 war fighter aircraft cost about £7,500 each, and bombers about £20,000. The cost of the day fighters in current production is not far short of £100,000 each, and that of the next generation of fighters is likely to be more than double that figure. The cost of bombers and military transports in current production is in the region of half a million pounds each. Future types are likely to exceed this figure considerably, as indeed do some of the types now being built in the U.S.A. Even allowing for the change in the value of money the increase is striking.

"I should like to give you a few more figures to illustrate the complexity of modern aircraft. These may be familiar to some of you, but I make no apology for quoting them since they serve to emphasize my point. Current British day fighters involve some 12-15,000 production drawings, and for one of the 'V' bombers about 20,000 production drawings, and about 45,000 loft plates are required. The number of jigs and tools is about 135,000. Incidentally, these figures exclude the engines.

"The Hampden bomber, built in the late 1930s, carried less than 150 lb of radio and electrical equipment and its electrical power consumption was about 6 kilowatts. The electrical and radio equipment in a well known modern bomber weighs nearly 9,000 lb, and the power consumption is in the region of 100 kW. In future types this last figure may well be doubled.

"In a current single-engined day fighter there are not far short of 250,000 rivets, and over 35,000 nuts, bolts and washers, which together account for a total weight of nearly 950 lb. In a light bomber the weight of these items is over 1,300 lb."

One obvious result of all this was that, bearing in mind that the national economy was likely to prevent any substantial increase in the amount of money available for the purchase of new aircraft for the Services, military aircraft in future were more likely to be ordered in tens than in hundreds or thousands. This had an obvious bearing on the amount of money which could reasonably be invested in capital equipment and tooling.

After turning his attention to the variety of design exemplified by present-day military aircraft, Mr. Woodward-Nutt made the point that we are still in an age of rapid advances in the art of aviation. He said that, except for certain very limited fields, we cannot yet count on a slow development along well-defined lines enabling a clear view to be taken of what lies 10 or 20 years ahead. On the contrary, he thought we would see quite drastic changes during at least the longer of these two periods; changes comparable with those which followed the advent of the gas turbine. A direct result of this was that constructional methods should have the greatest possible flexibility.

The remainder of the paper was devoted to an appraisal of integral methods of construction. The subject was considered from several aspects, most of which were shown to favour integration in construction more or less strongly. From the point of view of cost—probably the most important, and also the most controversial, aspect—it could be argued that integral construction permitted a saving in drawing and manufacturing details and in assembly time, which greatly outweighed the increased cost in machining time and scrap. On the other hand, one had to consider the cost of the plant and machinery required both to produce the initial plates, forgings or extrusions and to process them. Allowances also had to be made for the possibility of scrapping a large and costly part on which many man-hours had been spent.

Everyone seemed to agree that integral construction should lead to a reduction in weight, but the position from the point of view of strength was less clearly determined. Generally speaking, an integral structure should be more rigid and should also have a good fatigue life; on the other hand, the larger the original forging, the harder it was to ensure that the grain-flow in the finished part was satisfactory. Where high-speed aircraft were concerned, and particularly for the next generation of such aircraft, smoothness and lack of waviness in the external surface was of great importance; furthermore, it was essential to be able to repeat this degree of smoothness and close-tolerance exterior profile over a whole production run. Undoubtedly it was easier to do this with integral construction.

The lecturer expressed the feeling that integral forms of construction probably made possible an overall saving in time. Certainly, in the future, when automatic control equipment would permit drawings or numerical quantities and rough-machined parts to be fed into wholly automatic machine tools, it should be possible to achieve very accurate and rapid production. At present, however, errors at a late stage in a long machining cycle could not be completely discounted, and these could cause very serious delays. One also had to consider the time taken to make dies, forgings, and so forth, in the first place.

Mr. Woodward-Nutt's final aspect of the situation was that of flexibility; a word which he used to cover the adaptation of methods with changing demands, such as modification or a change in design. He made the telling point that, because we cannot afford to build the very expensive and complicated aircraft of the future in large quantities, any costly plant and tools involved should be capable of handling components for a series of designs. This might severely limit the degree to which integration could be applied. Under this heading also came the question of the possibility of rapid expansion of output such as might be required in times of emergency. It was essential that production facilities should be capable of being rapidly extended and, also of fundamental importance, should not be dependent at any stage upon one particular key plant or tool.

There were also other factors which depended on the methods of construction adopted. Two which came to the lecturer's mind were the ease with which an aircraft could be maintained and repaired, and the degree to which an aircraft was adaptable for retrospective modification.

Mr. Petter's Paper. The second of the two papers referred to above was that presented by Mr. W. E. W. Petter, C.B.E., B.A., F.R.Ae.S., managing director and chief engineer, Folland Aircraft, Ltd. He had been invited to expound upon the subject "Where Do We Go From Here?", and he succeeded, within the enormous scope allowed him, in making a number of characteristically pertinent observations.

He suggested at the outset that the real problem facing the industry at the present time was to keep production turning at all and "to produce things which can be used when they leave the hangar doors." The greatest problem of all, in his view, was to determine how to canalize the work of our limited research, designing and development manpower through the right channels

PRODUCTION CONFERENCE . . .

in order that we might have a certain number of producible aeroplanes to meet our essential needs at the right time. He likened our air effort to a three-legged stool, one leg being the customer, another the industry and the third a supply organization to co-ordinate the other two. Weakness in any leg immediately showed itself in the outcome of our efforts and "because there have been weaknesses in each," our air situation was today far from satisfactory.

The framing of requirements, particularly in the military field, was an appalling responsibility. If over-ambitious, the problems set to the designer would be of such complexity that he would either be very late or would not achieve production at all; if too easy we might be faced with an enemy or competitor possessing technical superiority.

He went on: "The specification writers since the war have in my opinion tended to set their sights much too high; they have aimed too far ahead—and no doubt the Industry (in which I include the equipment and armament manufacturers who, together with the engine and airframe people, make up the weapons system), must take a grave responsibility for being too ready in their promises. We have for instance, underestimated the difficulties of supersonic flight, the time scale of new radar sets, the time to develop new weapons. A somewhat doubtful time scale has perhaps, seemed unimportant in a political background which seems to have always put any war possibility a comfortable four to five years ahead!

"On the industrial side our gravest fault has been, I think, over-commitment. Too many channels for too little water. Designing and developing an aeroplane today is a tremendous undertaking and it needs the almost undivided attention of whoever in the firm is the chief design executive, together with all his staff, for a period of five to six years—three perhaps for the project work and the design and building of the prototypes, and three thereafter to make them work in association with the customer, and to incorporate such modifications as are needed for production. The number of men who combine the qualities of leadership, inventiveness and diplomacy with those of character necessary for the top design job certainly appear to be no more than the number of approved aircraft firms today; apart from the leaders there are hardly sufficient sound lieutenants, the people who really do much of the work, to go round even the good existing teams, and the same is found even more acutely at the level of designers and technicians."

It seemed to Mr. Petter that there was a tendency for factory managements to seek expansion at all costs and so to demand an ever-increasing flow of prototypes, so that with due allowance for failure, there would always be an assured large production. This was the dance of death for the designers; fewer new endeavours, carried to fruition, would ensure more, and not fewer, production successes. It also appeared that much could be done to assist production by increasing the scope of sub-contracting and also by encouraging production staffs to help more in the development stages. Admittedly, more would be foreseen and modifications would be fewer if the British industry were less over-committed, but it would nevertheless be of inestimable help if production people could adopt a more sympathetic attitude to important modifications.

It might in fact be argued that we should forget all about new production techniques until we had overcome the lamentable state of affairs which existed when urgently needed aircraft went from the factory not to the Services, but for weeks or months to Service modification units. A new major aircraft every six years or so might not altogether satisfy the younger technical and project designers. The solution was probably to sandwich in research design and flight work, of which much needed to be done and for which contracts could usually be obtained, choosing a subject in accordance with the firm's interests.

Another weakness in the industrial leg of the British tripod was due to unbalanced organization; too much emphasis was often given to the production and commercial side and a quite inadequate weight to engineering. The top engineer executive should be, as he is in America, at least a Vice-president, Engineering, in name and in fact. There was still in some firms a tendency "to regard the design head as a back-room boy to be brought out only on gala occasions."

Turning to the third leg of the stool—the supply and production ministry responsible for co-ordination—Mr. Petter said that this had power for good or ill which had not always been realized or well exercised. It had the power of handing out rewards and pains for good or bad industrial performance, and it was the speaker's opinion that it would only do good if rewards and pains could be magnified.

Mr. Petter welcomed the policy of taking shorter steps in design that now seemed to be finding favour. If one aimed seven years ahead the problem postulated was such that the chances of success of each of the airframe, weapon and guidance equipment was probably not more than one in two. Taking all together, therefore, there was a one in eight chance of success, further reduced by any power plant disappointments—and a one in eight chance which, in fact, probably took ten and not seven years, was not good enough. If a target of only four to five years was taken, the chances on the aircraft, weapon and guidance should be at least three: four each, so that the overall project should have something better than a 27 to 64 chance. What was much more, it was likely to be on or near schedule. It was also less liable to policy changes which might render it useless, and the shorter time scale made it easier to anticipate what might be required in the event of a partial failure of any part of the whole weapons system.

"At any rate," said Mr. Petter, "the chances of success in time—and there is no other success in aviation—is about four times as good in the short step as in the long. In fact in this way your people would get something to produce."

The paper went on to discuss nationalization or, alternatively, large-scale rationalization—in the author's view, neither offered any hope whatever. For their correct functioning and mutual interconnection the three complementary supports of our air effort had to be administratively independent. Mr. Petter could see nothing but ossification arising from any attempt to put all three under one roof. Comparisons were drawn with the state of the industry and Ministries before the war, "when an impoverished industry was increasingly wrapped up in biplanes and red tape by the users and the Ministry."

The solution of industrial rationalization was superficially more attractive, and, for big machines requiring large resources, sizeable units were undoubtedly necessary. On the other hand, it was the author's opinion that the best results should be obtained from units in which the technical and design staffs, excluding the experimental shops, probably consisted of 100 to 200. For the design team to be of any use its firm had to be a producer and tooler-up of aircraft, since much of the design effort had to be in the creation of light, simple and producible detail, and this art was quickly forgotten by those no longer associated with production.

A VERDICT STILL AWAITED

UNREASONABLY, perhaps, we and a great many others had expected that the result of the Comet Inquiry would by this time have been published. There was, in fact, a rumour that the work would be completed by Christmas. So much depends or is waiting upon the findings that each day's delay is a serious matter, not only for the de Havilland Company and its employees, but also the operators—British, French and Canadian—concerned. In the accompanying photograph Series 1 Comets are seen "hibernating" at London Airport.

There seems to be no doubt that the R.A.F. could make good use of any of the existing Comet 2s they might be authorized to purchase and also, for different purposes, of a few Series 1s. Transport Command has been seriously neglected so far as new equipment is concerned, and when it eventually receives Vickers 1000s, the enormous step from its current types will probably be a difficult one to take.

The announcement of R.A.F. purchase of Comets in the expected event of the findings of the Court of Inquiry leaving the way open for such action would provide not only a much-needed stimulant for R.A.F. transportation, but would also help considerably toward the re-establishment of confidence in Comets and, later, in their re-introduction to passenger service in one or more of the later versions.

The French Services, likewise, might profit by the acquisition of a few Comet 1s from Air France or U.A.T.

In the cold: Comet 1s at London Airport, Cocooned and snow-clad, await the results of the Court of Inquiry—as do the later series Comets.

AIRCRAFT ARMAMENT PART I

GUNS FOR FIGHTERS

THIS is a particularly appropriate time at which to review the subject of aircraft guns. The British and American air forces are now introducing examples of what may be the last basic family of airborne cannon—for it seems probable that, during the next decade, guns as we know them today will be progressively superseded by other types of weapon; in fact, as is shown elsewhere in this issue, the process has already begun.

Before discussing specific types of gun we may briefly consider some of the criteria governing acceptance or rejection of this type of armament. One of the principal factors is weight. The modern aircraft cannon has an installed weight, with accessories, of between 150 and 450 lb, and a single round of ammunition, plus belt link, weights about 0.9 lb (20 mm) or 2.1 lb (30 mm). Thus, an installation of four 30 mm guns, each with 300 rounds of ammunition, would weigh no less than 4,000 lb. Allowance also has to be made for the weight penalty of the mountings and surrounding airframe stressed to carry the armament and recoil loads.

The principal alternative type of armament is the self-propelled weapon, either of the unguided or guided variety. The unguided missile is not new in concept, but it is only in the past three years that it has actually begun to *supplant* the gun. Even today, gunless armament is found only in U.S.A.F. all-weather squadrons. The air-launched guided weapon is of much later conception and is not yet in full service anywhere.

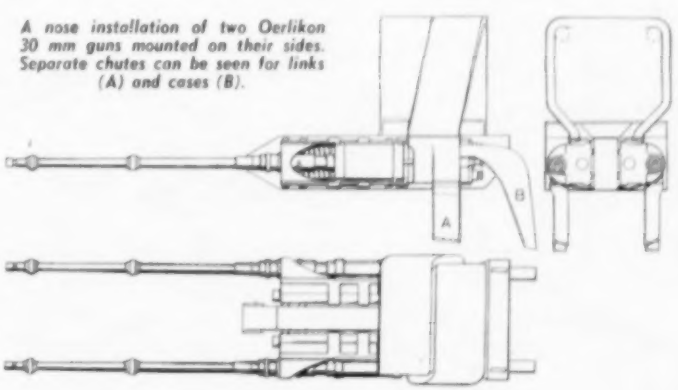
All self-propelled missiles enjoy a great advantage over the gun, in that they require no more than a rudimentary launching mechanism. Furthermore, they can be treated almost as can a "dead" store, such as a supply container, in that no muzzle flash or recoil has to be dissipated. Consequently, weight can be saved on these grounds.

Any attempt at a relative assessment of guns *versus* self-propelled weapons can arrive at only general conclusions. Use of self-propelled missiles may permit an overall saving in weight, particularly after the weapon has been launched. Accuracy of guided and unguided missiles can be adequate at all ranges at which they can be used, and this range can be considerably greater than that possible with gun armament. Individual missiles are larger and far more costly than gun ammunition (this is particularly true of guided weapons, which may cost as much as 100,000 rounds of 20 mm); but this is offset by the fact that one strike is normally sufficient to knock out any aircraft.

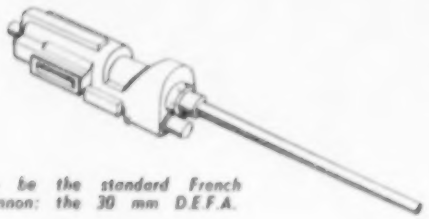
Unguided missiles can be carried in, or under, any convenient part of a fighter; in fact, a number of automatic magazine-fed launchers for folding-fin, rotation-stabilized missiles have been developed in America and installed in such aircraft as the Skyraider (wings) and Scorpion (nose). Guided weapons are generally carried externally, involving an increase in drag. Since the configuration of most fighters precludes stowage under the fuselage, the only space available is under the wings, with a consequent reduction in the fighter's rate of roll. Air-launched missiles are discussed on p. 114 *et seq.*

The installation of efficient gun armament is probably at least as difficult as is that of self-propelled missiles. Some of the more obvious factors which a gun installation has to take into account are the following: proper ammunition feed under all conditions of temperature, vibration and acceleration loading; muzzle blast and flash; recoil; discharge of exhaust gas, spent cases and links; and integration with sighting equipment and radar.

The aircraft structure around gun muzzles is subjected to rapid and violent pressure pulsations of a type which may be expected to cause fatigue problems. Furthermore, the muzzle blast, together with entrained cooling air, creates a region around the muzzles in which the local flow opposes the slipstream; although this is rarely of importance from the point of view of stability or control of the aircraft, it is worth noting that, if this region is near engine intakes, great care has to be exercised if engine performance is not to be impaired. The flash from high-velocity cannon may extend for several feet and, while hardly dazzling in daylight, is capable of destroying night vision unless the armament is so situated that the flash cannot be seen by the aircraft crew, either directly or by reflection.



A nose installation of two Oerlikon 30 mm guns mounted on their sides. Separate chutes can be seen for links (A) and cases (B).



To be the standard French cannon: the 30 mm D.E.F.A.

The Mig-15 (p. 112) is armed with one 37 mm N (Nudelmann) gun and two 23 mm NS (Nudelmann-Suranov) weapons, all mounted on a quickly demountable tray. A 37 mm round is seen at bottom-right.

GUNS FOR FIGHTERS . . .

Recoil is not a great problem of itself, although it may be of sufficient magnitude to cause complete modification of the loading in the surrounding structure. Moreover, recoil loads are by no means steady; they can vary from a maximum down to zero, or even to a reverse loading, with each round fired; and this, also, may cause fatigue problems. There is much to be said for keeping guns close to the aircraft centre line, for this provides concentrated fire at all ranges, and obviates the danger of an asymmetric yawing moment such as could occur were wing-mounted guns to fire on one side of the aircraft only. If the latter were to occur at extreme altitude, it might result in a fighter losing a great deal of height and possibly having to abandon its mission.

Another factor which has to be considered is that, generally speaking, fixed-gun armament has to be installed well forward, in a position where variation in weight produces a considerable change in the trim of the aircraft. The magnitude of this effect is illustrated by the fact that 1,200 rounds of 30 mm ammunition weigh one ton and, fired from four guns, this weight could theoretically be discharged in 15 seconds. Fighter-borne guided weapons are not only lighter on the whole, but they can be carried in such a position that, with good design, their launching produces no change in trim.

The gas produced by the combustion of most propellants is less innocuous than might be supposed. In suitable concentrations, it can be poisonous, inflammable and even explosive. Gas issuing from the muzzle is immediately diluted and usually causes no trouble, but the hot gas from the breech normally has to be contained within the weapons bay and, so far as possible, prevented from entering the fuselage. During flight-testing of aircraft, a great deal of effort is expended in sampling the gas in the weapons bay and other parts of the aircraft and in improving methods of discharging it overboard. The Hunter and Swift, for example, both have what appear to be gun exhaust pipes of at least 3in diameter terminating flush with the skin under the fuselage.

The disposal of empty cases and belt links can also raise problems. Two or three hundred 30 mm cases represent a formidable bulk and weight. A spent case is almost worthless; there are a number of reasons why it cannot be reclaimed, two of them being deformation of the lip and expansion during firing. Sometimes it is possible to arrange for the cases to drop overboard under gravity, but provision has also to be made for discharging them under any flying conditions—even those of negative g. Furthermore, local airflow conditions may be disturbed (particularly when mixed with muzzle blast) and, just as a car driver's discarded cigarette-end can re-enter by a rear window, so can a case be thrown violently against the aircraft and cause severe damage. The Meteor 8 and Sea Hawk both drop cases through large chutes, so that they enter undisturbed slipstream and fall away cleanly.

Owing to this difficulty of effecting positive expulsion under all conditions, supersonic fighters may even have to retain spent cases or links on board; otherwise there is the risk that they may damage the airframe, or be sucked into the engine intake(s). On the Gnat, a transporter system will take cases from the two Aden guns and dump them in the rear fuselage, whence they can be scooped out after each mission. A simpler, though unattractive, alternative would be to install bulged external link-collection panniers directly beneath the guns themselves.

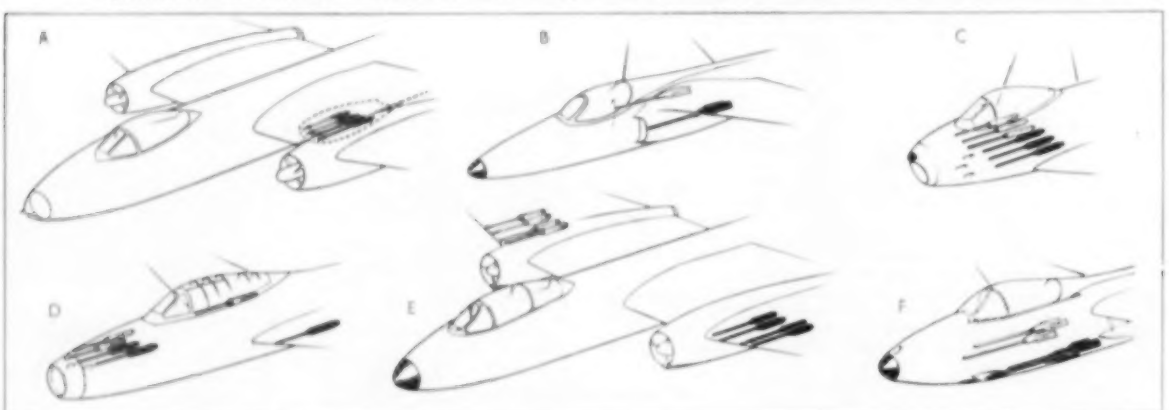
Ammunition is normally contained in a rectangular tank, which accommodates a belt fitted in overlapping layers. The filled tank may weigh as much as 800 lb (usually much less); it may slide into the aircraft on rails, and is normally locked to the airframe but not to the gun which it feeds. The belt is commonly pulled from the tank by a feed-assister before being introduced to the gun. A mechanically driven sprocket, the feed-assister greatly reduces the load on the transporter mechanism of the gun and the strain on the belt; this strain can be very high when the belt is accelerating immediately after the guns are first fired and is further accentuated by acceleration loads caused by combat manœuvre.

Of the several forms which the belt can take, that most common

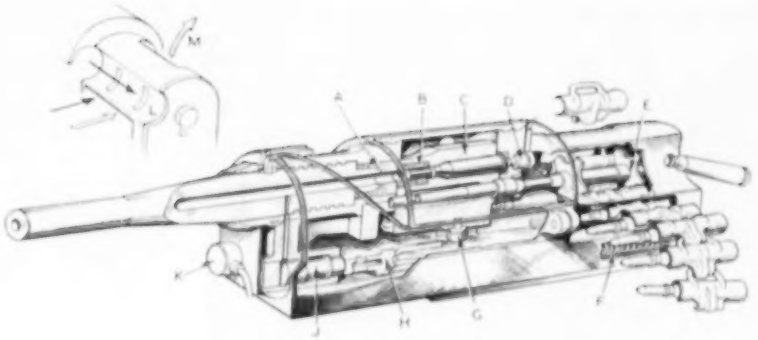
FACTORS AFFECTING GUN DESIGN

FOR	AGAINST
High Rate of Fire	
More strikes during brief period "on target."	Short total duration of fire. Shorter barrel life. Severe mechanical problems. Lower useful life of gun.
Large Calibre	
Fewer strikes needed for kill. Better fusing. Probably better ratio of H.E. weight to total weight of projectile.	Greater weight of gun and ammunition. More difficult feed for given rate of fire. More difficult installation in aircraft. May impair flying qualities when firing.
High Muzzle Velocity	
Greater accuracy at long range. Greater penetration of armour-piercing rounds. Greater effective range.	Shorter barrel life. Greater weight of gun and ammunition. Worse muzzle blast and flash.

Drawings illustrating the variety of fixed-gun installations in present-day aircraft: A, English Electric Canberra B.8 (four 20 mm); B, Folland Fo.139 Gnat (two 30 mm); C, North American F-86F Sabre (six 0.5in); D, Republic F-84G Thunderjet (six 0.5in); E, Martin B-57B (eight 0.5in); F, Hawker Hunter F.1 (four 30 mm). Guns mounted on the port side are shown in solid black: those to starboard are outlined.



Forerunner of all modern aircraft cannon, the Mauser MG-213C was probably the most significant automatic weapon of this century. It was developed during 1944-5.



A, temperature-resistant-steel breech; B, gas-tight chamber; C, revolving cylinder (with five chambers, one being shown in the 12-o'clock firing position); D, electric igniter; E, twin feed-wheels; F, main recoil springs; G, cylinder-drive stud; H, reciprocating slide; J, short-stroke gas piston; K, electric/pneumatic cocking connection; L, ejection of cases (black arrow); M, ejection of open links (white arrow).

to aircraft guns is the disintegrating metal-link type. In such guns as the familiar Browning, the links are so designed that rounds have to be extracted by the feed mechanism towards the rear, i.e. they are pulled out of the belt. Modern guns use open-link ammunition which can be pushed *forwards* out of the belt and rammed into the firing chamber in one movement. If the belt is to traverse any appreciable distance of free space in its passage to the gun, it is almost universal to support it in a flexible metal guide of the type shown in the photographs of the M-39 cannon. The ammunition may have to be coated with a non-freezing high-altitude oil to reduce friction in high-speed feedways.

In most aircraft, the gun mountings are attached to fixed portions of airframe, with a slight adjustment which permits the barrels to be precisely related to the sighting system and radar aerial. When guns are required in the armoury for inspection or repair, their removal may well take half an hour or more. During this time, the aircraft is unserviceable from the combat point of view; it is also unserviceable during the ten minutes or so which may be required to change ammunition tanks.

The modern trend is to have the entire weapons installation, complete with ammunition, mounted in a single "pack" which can be winched up into the aircraft in a matter of one or two minutes. By so doing, it is possible for a fighter squadron to maintain a number of armament installations permanently ready for exchange. Such a system is already used on several modern fighters, two of which can be named as being the Hunter and Mig-15. This arrangement can also, under certain circumstances, facilitate conversion from the fighter to the photo-reconnaissance rôle.

In most modern fighters, the ammunition tanks are formed from parallel sheets spaced just far enough apart to admit the belt of ammunition. The belt leaves the tank *via* a rigid chute and this chute generally curves downwards so that the gun can be mounted on the lower flank of the fuselage. As a result the ammunition passes through the gun from top to bottom, and consequently the cannon of most modern fighters are mounted lying on their sides. The diagram of a Swiss installation shows cannon turned through 90 deg and attached to a vertical mounting structure. Wing-mounted guns, on the other hand, are invariably "the right way up."

Some Contemporary Guns Reviewed. The remainder of this survey is devoted to some of the types of gun developed since the end of World War 2. The principal factors affecting the design of a gun are listed in the table opposite; the form which the weapon takes is clearly a compromise between directly conflicting factors.

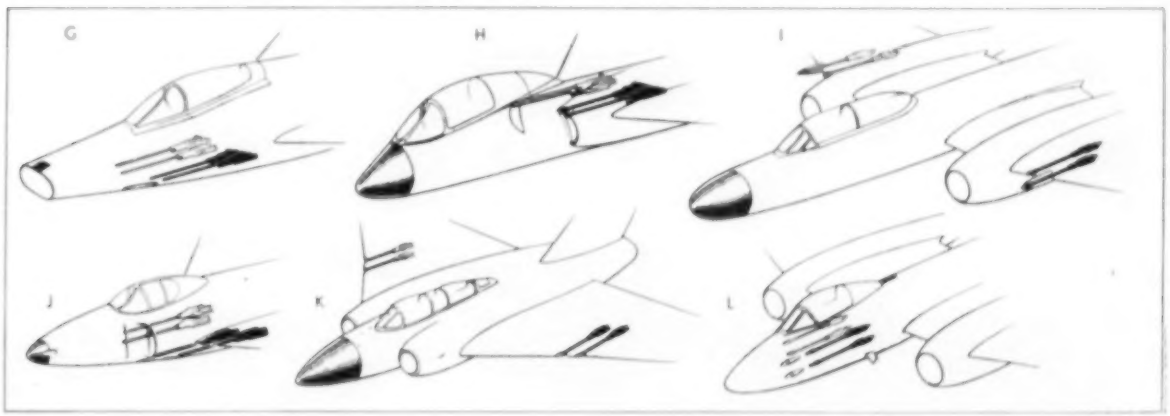
It is remarkable that neither ourselves nor the U.S.A. introduced any new type of aircraft gun during the 1939-45 war, with the exception of large weapons with limited application, such as the Vickers S, the Rolls-Royce 40 mm, the 6-pounder, and the American 75 mm (the final form of which was automatically fed from a 15-round charger). It is even more surprising that the three basic aircraft weapons of the Allies, the 0.303in and 0.5in Brownings, and the 20 mm Hispano, were all designed long before 1939. Very little about the three weapons requires comment, apart from the fact that each has been manufactured on a vast scale and that all are still standard weapons.

The position in Germany was very different. The Luftwaffe entered the war armed with the Rheinmetall-Borsig MG-15 and MG-17 rifle-calibre guns, and the Oerlikon (usually the MG-FF) 20 mm cannon. Throughout the conflict the performance of the Luftwaffe's guns was analyzed and strenuous efforts were made to effect improvements. This contrasts sharply with the Allied outlook, which appears to have been to consolidate and increase reliability and standardization.

By 1940, aircraft were being widely fitted with self-sealing tanks and considerable armour, and their vulnerability had decreased to a point at which rifle-calibre weapons were of much-reduced effectiveness. By the end of that year, only one German rifle-calibre gun was being developed for aircraft use and this (the MG-81) was a light and fast-firing weapon used almost exclusively in multiple installations for defensive purposes.

The MG-131, of 13 mm calibre, was adopted for both fixed mountings and defensive turrets, and the later fighters were being armed with the wholly new MG-151 developed by the Mauser company. This gun existed in two forms, with bores of 15 and 20 mm; it was a high-velocity weapon of exceptional quality and it incorporated electrical fusing (introduced on the MG-131) whereby each round was fired by a small electrical primer ignited by a wire heated to incandescence, instead of by the more normal percussion cap deformed by a striker. The MG-151 was a considerable advance on any previous fighter weapon, and in passing it may be noted that, during and after the war, it was developed in America under the designation T-17 Gun, Automatic, 0.60in.

Six further types of gun installation, radar equipment for searching or sighting being shown in black: G, North American F-100A Super Sabre (four 20 mm); H, Chance Vought F7U-3 Cutlass (four 20 mm); I, Armstrong Whitworth Meteor N.F.14 (four 20 mm); J, Supermarine Swift F.4 (four 30 mm); K, Gloster Javelin F.A.W.1 (four 30 mm); L, Gloster Meteor F.8 (four 20 mm).



GUNS FOR FIGHTERS . . .

The T-17 had a high muzzle velocity, but it fired only solid projectiles, and was therefore abandoned.

Corresponding developments in ammunition took place. Quite early it was decided that, in spite of the increasing use of armour, the high-explosive round was the most effective type of projectile for normal combat use. Efforts were made to increase the ratio of weight of explosive to the weight of the case, and startling results were achieved in the development of thin-walled "mine ammunition." For example, the original German 20 mm shell contained 18 grammes of explosive out of a total weight of 90 grammes, and the 30 mm H.E./tracer contained 72 grammes out of a total weight of 330 gm. It was not found possible to make any significant decrease in the thickness of the case, but lengthening the shell made possible an increase of as much as 30 per cent in explosive content, beyond which point muzzle velocity decreased inordinately. (The fineness ratio of a projectile is denoted by expressing its length as a multiple of the calibre.)

By this means, 20 mm ammunition with a length of 5.2 calibres was developed, with an explosive charge of 24 or even 27 grammes. By eliminating the tracer the revised 30 mm shell could be made to carry 85 grammes of explosive, and later developments—which were not employed in combat—envisaged increasing the charge to as much as 110 grammes (almost ¼ lb). At the same time, improvements in explosives and propellants, the development of incendiary H.E. and the use of special delayed detonators made possible the achievement of a maximum effective action for each calibre. Even in 1955 it is doubtful if these results have been significantly improved upon.

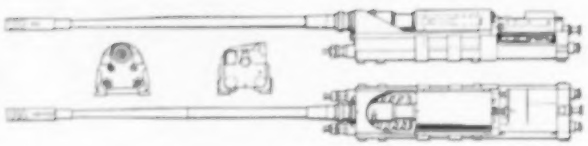
By 1942, the Germans had decided that even 20 mm was the *minimum* useful calibre for air-to-air combat. Already, a 30 mm weapon (the MK-101) was in service and, although it was slow-firing and generally uninspired in conception, it was an effective weapon. Moreover, it served as a basis from which the considerably better MK-103 and 108 (see table) were developed. Some 12 years ago, the standard armament for the then-projected Me 262 twin-jet fighter was chosen as four MK-108s, representing a "punch" which has only recently been exceeded with the introduction of our latest fighters.

During the winter of 1942-43, the Mauser company were actively developing the MG-213A, which was a high-performance cannon embodying all the combat experience amassed up to that time. The MG-213A embodied no revolutionary principles and was merely a very good weapon in 20 mm calibre. Nevertheless, the Mauser engineers knew that they could do a lot better working along fundamentally new lines. In particular, it seemed clear that guns of conventional pattern were already very close to the practical limit of cyclic firing rate* imposed by considerations of inertia, mechanical strength and the difficulty of effecting a positive control of the ammunition as it passed through the gun.

At this point, it should be made clear that, during World War 2 and later, several countries produced a number of highly unconventional weapons, including recoil-less guns firing projectiles of up to 5in calibre; a gun with three distinct breech assemblies spaced at 120 deg around a rotating cylinder; and another in which a number of projectiles were discharged under the influence of a single propellant charge. But none of these was really successful, and all the important cannon of today have stemmed from the weapon which will shortly be described.

The MG-213A was a gas-operated weapon, and a notable feature was the inclusion of a pivoted multiplying lever in the linkage between the gas piston and the recoiling portions of the mechanism.

*Cyclic rate: the rate at which an automatic weapon fires successive rounds. A cyclic rate of 1,000 rounds per minute does not necessarily mean that in one minute 1,000 rounds can be fired.



General arrangement of the Oerlikon 302 RK 30 mm gun. The overall length is 117in, the maximum width 11in and the weight 398 lb.

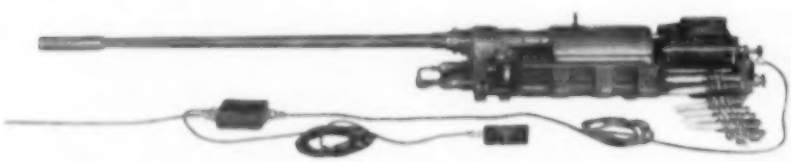
This threw the breech block to the rear at more than twice the speed of the gas piston and made possible a cyclic firing rate exceeding 1,000 rounds per minute, albeit at some expense in wear and tear. The Mauser company completely redesigned the 213A, utilizing a principle which was by no means new but which

CHARACTERISTICS OF SOME MODERN AIRCRAFT GUNS

Country and designation	Calibre mm	Calibre in	Weight of gun (lb)	Weight of projectile (lb)	Max. cyclic rate of fire (r.p.m.)	Muzzle velocity (ft/sec)
Great Britain						
Browning 0.303in Mk 2	7.7	0.303	21.9	0.022	1,200	2,600
British Hispano 20mm Mk 5	20	0.787	106	0.27	650	2,750
Aden 30mm	30	1.181	n.a.	n.a.	1,200*	n.a.
France						
D.E.F.A.	30	1.181	n.a.	n.a.	n.a.	n.a.
Hispano Model 606	30	1.181	n.a.	n.a.	n.a.	n.a.
Germany						
Rheinmetall MG-81	7.92	0.311	13.9	0.028	1,500	2,675
MG-131	13	0.511	40	0.13	700	2,370
Mauser MG-151/20	20	0.787	93.5	0.3	750	2,500
Rheinmetall MK-101	30	1.181	323	0.728	250	2,900
MK-103	30	1.181	289	0.728	420	1,657
MK-108	30	1.181	135	0.728	450	2,900
MK-115	55	2.165	390	3.4	300	2,000
Mauser MG-213A	20	0.787	113	0.33	1,100	3,280
MG-213C/20	20	0.787	165	0.42	1,500	3,000
MG-213C/30	30	1.181	170	0.73	1,200	1,805
Rheinmetall MK-412	55	2.165	608	3.2	250	1,900
Switzerland						
Oerlikon 206 RK	20	0.787	199	0.276	1,800	3,510
302 RK	30	1.181	398	0.662	1,200	3,610
U.S.A.						
Colt-Browning M-3	12.7	0.5	52	0.106	1,100	2,500
T-17	15.2	0.6	109	0.16	1,200	3,500
M-39	20	0.787	170	n.a.	1,500	3,400

* According to foreign publications.

Pneumatic cocking equipment for the 30 mm Aden. Developed by Dunlop, this unit works at 1,200 lb/sq in (max. working pressure, 4,000 lb/sq in), and moves a two-stage ram.



A complete Oerlikon 302 RK weapon, showing pneumatic and electric connections, cables and cockpit control box. This gun has an unsurpassed combination of rate of fire, calibre and muzzle velocity.

The business end of a 20 mm Oerlikon 206 RK. This gun, which fires at cyclic rates exceeding 1,700 r.p.m., ejects cases through the large pipe and belt links through the slot just above the pipe.

had not previously been adopted in such a calibre. The redesigned weapon was the MG-213C and was the first modern *revolver cannon* for aircraft use.

Like the original 213A, the new gun was gas-operated; but the gas piston, instead of driving a heavy breech block, was merely attached to a light two-stage reciprocating member, known as a rammer, the function of which was to take cartridges out of the belt and ram them into one of five chambers of a cylinder identical in form with the cylinder of a revolver. At the same time, the reciprocating motion of the rammer turned the cylinder (anti-clockwise, seen from the rear), by means of a diagonal cam on the operating slide and a cam follower on the cylinder. Most MG-213s were fitted for left-hand feed and consequently each new round was inserted into the chamber at "5 o'clock" viewed from the rear, the belt being driven by a feed-wheel on the cylinder shaft. The round was carried to the 12 o'clock position, in line with the barrel, and fired by an electric igniter.

At the moment of firing, the cartridge was held solely by the cylinder chamber, which was rendered gas-tight by packing of heat-resistant steel on the cylinder and barrel (see diagram, p. 107). The base of the shell case was supported by a rigid breech body in which the cylinder was mounted. The gas tapping for operating the weapon was placed very close to the chamber and, as the breech was not opened by rotation of the cylinder (and also owing to the very low inertia of the moving parts) it was possible for the mechanism to be in full motion before the projectile had left the barrel and while the gas pressure was still extremely high. This alone permitted a significant increase in the cyclic rate of fire; another good feature was that each round did not have to pass through the whole cycle of operations before the next cycle could begin, for in the revolver cannon there are always at least three rounds passing through the gun together, each at a different point in the firing cycle (feeding, firing and extraction). Other advantages of the arrangement are that cooling is easier and that the calibre of a design can be changed more readily than can that of a conventional weapon.

So far as is known, the MG-213C was never used in air combat, but there is no doubt that it was years ahead of any other aircraft gun. In fact there was no comparable weapon, and it soon engaged the attention of armament experts everywhere, once captured specimens became available after the German capitulation. Three of the chief lines of development of the gun are those which have taken place in this country, Switzerland and the U.S.A.

Of British work, little can yet be disclosed. In the spring of last year, Mr. Duncan Sandys, then Minister of Supply, made official reference to a new cannon known as the Aden (a contraction of "Armament Development, Enfield") with a bore of 30 mm. The Minister made the following statement at that time: "With this powerful cannon, the Swift is capable of bringing to bear against an enemy aircraft eight times more high explosive than was possible with earlier types of guns. Its revolutionary design gives the Aden cannon about twice the rate of fire of the 20 mm Hispano gun, which has been our standard fighter weapon since 1941. Trials have proved that the Aden, with its advanced type of gun-sights and quick-acting fuse, is capable of inflicting devastating damage. The introduction of the Swift, with its superb flying performance and terrific fire power, is a milestone in the progress of Britain's air defence."

It was probably a very wise move to standardize the calibre of the Aden at 30 mm, although the corresponding American weapon has a bore 10 mm less. No details of the gun have been released for publication, but the mere fact that development has taken about eight years can be taken as indicative of its quality. It is, incidentally, the first wholly British gun since the Great War to become standard armament in the R.A.F. From the Minister's statement, it would seem that a single Swift or Hunter with four Adens can bring to bear roughly the same fire power as can a whole squadron of Meteors. Incidentally, the initial air-firing trials and much of the development of the Aden were carried out with the weapon mounted in Meteor airframes. Prototype Adens were manufactured by the Ministry of Supply Royal Ordnance Factories, and the gun is now in large-scale production, a principal contractor being the B.S.A. company.

In Switzerland, the renowned Oerlikon company are maintaining their position as one of the world's principal suppliers of automatic weapons. From the MG-213C they have developed two superb revolver cannon, the 206 RK (20 mm) and the 302 RK (30 mm). Both have a layout similar to the German gun, with a five-cylinder chamber mounted below the line of the barrel so that the round being fired is indexed at the 12 o'clock position. Both the Oerlikon weapons are fired by a belt (left- or right-hand feed) pulled into the gun by a star-wheel floating axially on the cylinder shaft. The cylinder is loaded by a two-stage extension to the gas-operated slide which turns the cylinder.

A development model M-39 on test, firing at long range in the open air. Points worth noting are the ammunition feed and electric ignition cable. The photograph was probably taken during 1952.

The gun casing is rigidly attached to the airframe and carries an axially floating barrel on a drum casing, which can recoil against a pair of springs. Early versions of the guns were equipped for cocking by a pneumatic system working at 560 lb/sq in; the modern 206 RK and 302 RK are cocked by a specially developed cartridge device, a magazine of 12 electrically ignited cartridges being available for one mission. Ignition of the main ammunition is also electric, and when the gun ceases firing one round is left in the firing position.

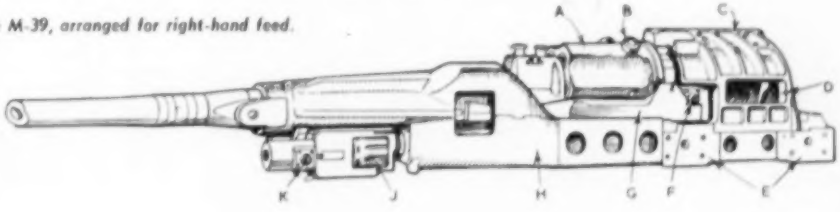
The third important descendant of the MG-213C is a cannon which is rapidly coming into large-scale service with the U.S.A.F. and other American services under the designation M-39. Original development from the Mauser gun was carried out by the Armor Research Foundation of the Illinois Institute of Technology assisted by the Springfield (Mass.) Armory. Various experimental weapons (models A, B, C and D) were produced and, in the course of development, a bore of 20 mm was accepted as final and the German mechanism was partly inverted, the axis of the M-39 cylinder being above that of the barrel.

The outbreak of war in Korea caused the work to be urgently accelerated and, late in 1950, the Ford Motor Company was called in to produce the M-39D and assist in further development. The company formed a special weapon development group under Ray L. Morrissey (a scout pilot in the Great War and a cannon production expert in World War 2), who promised to have a working model ready in four months. Utilizing the resources of Ford's Dearborn tool and die plant, the first gun from the original designs was completed one month early, in June, 1951. This weapon jammed frequently, but a redesign was effected by July. By December, several of the improved guns, designated M-39E, had been delivered.

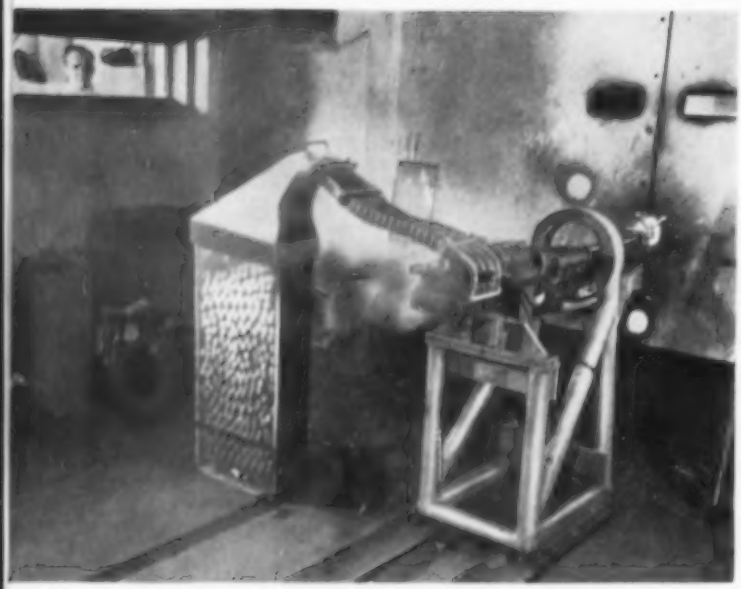
The Army Ordnance Department, who are responsible for U.S.A.F. guns, then decided that this was the answer to their search for a new rapid-fire aircraft cannon, and Ford were awarded a further development contract for several hundred M-39Es for test purposes. The company built a special firing range in the Rouge factory, a test stand being illustrated overleaf. Late in 1952, several M-39Es were installed in F-86F Sabres and, after a shake-down test at Edwards A.F.B., were shipped to the Far East for combat suitability trials.

A test team, headed by Maj. Raymond E. Evans, of the U.S.A.F.

Standard 1954 production M-39, arranged for right-hand feed.



A, five-chamber cylinder, mounted above the axis of the barrel; B, cylinder-drive stud; C, ammunition feedway; D, link-ejection opening; E, mounting faces; F, electric ignition socket; G, main yoke-piece; H, bed-frame; J, cylinder for cocking-cartridges; K, electric socket for indexing and firing cocking-cartridges.

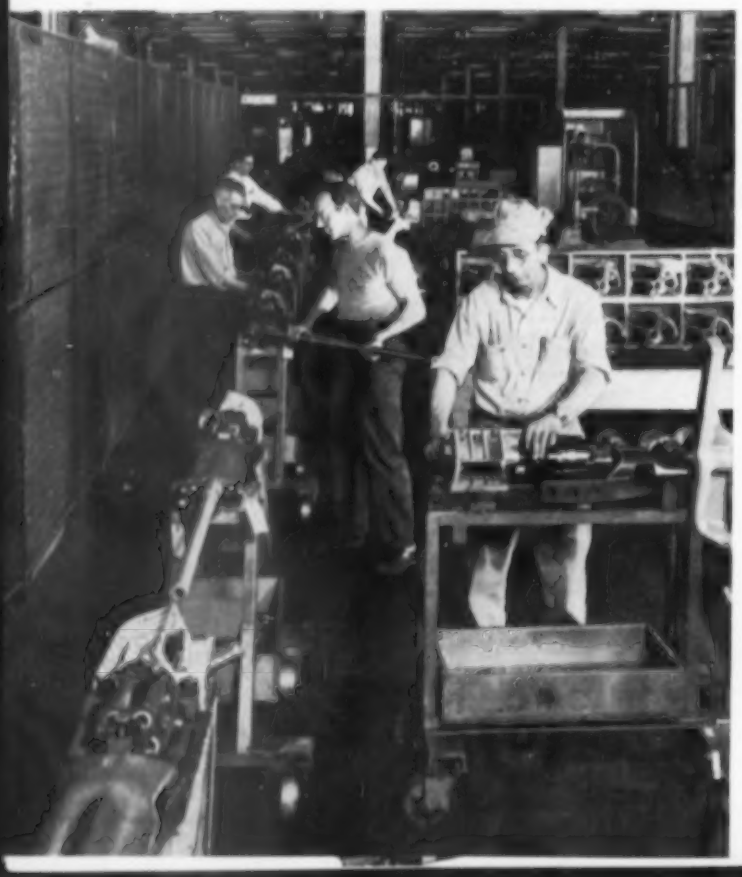


An M-39 is here shown undergoing firing tests at the Ford Motor Company's factory at Rouge, Dearborn, Michigan. The fastest-firing gun in use by any of America's armed forces, the M-39 ejects empty cases through a side-pipe; the camera has "stopped" several cases in mid-air.

GUNS FOR FIGHTERS . . .

Air Proving Ground Command, was formed to supervise the tests. Members were chosen from Air Research and Development Command; Tactical Air Command; Air Training Command; Wright Air Development Center; Aberdeen Proving Ground; North American Aviation, Inc.; Ford Motor Company; Sperry Gyroscope Company; and General Electric Company. In Korea the flying phase of the programme was conducted early in 1953 under the operational control of Far East Air Forces, with the assistance and participation of personnel of the Fourth Engineer Intercepter Wing. To obtain as much information as possible in the minimum time, the Sabres were scheduled only on missions which had the highest probability of engaging enemy aircraft. In the short time that it was in combat the gun accounted for six Mig-15s destroyed, three probably destroyed, and 12 damaged.

Production of the M-39 is being handled principally by the Pontiac Motor Division of General Motors. The assembly line has looked like this for nearly three years. It can be seen that these guns, most of which are for F-100s or F-86Ks, are alternately fitted for left- and right-hand feed.



The gun met both Ordnance and Air Force requirements, and a final production model was then chosen, incorporating recommendations made by pilots and other members of the test team. The Pontiac Motor Division of the General Motors Corporation were given a very large production contract for the gun and most of the M-39s now being delivered are of Pontiac manufacture. This company introduced a number of engineering changes last year, several of which were aimed at increasing the component life.

Like other weapons of MG-213C descent, the M-39 is a five-chamber, belt-fed revolver cannon with gas operation and electric ignition. Owing to the high mounting of the cylinder, the locking saddle of the German design is replaced by a massive yoke passing along each side of the cylinder, and open underneath to allow the cam grooves in the gas-operated slide to engage the studs on the cylinder. It may be noted that the inversion of the relative positions of the cylinder and barrel axes has required re-location of the studs directly over each chamber (instead of between adjacent chambers) since one stud and chamber must both be at 6 o'clock at the moment of firing.

Cocking of the M-39 is carried out in a manner similar to that employed by Oerlikon, namely, by a cartridge which supplies gas to the main gas-operated ram. One of our drawings shows the auxiliary chamber which accommodates electrically-indexed and fired rounds for this purpose.

Compared with the Aden, the M-39 cannot have comparable "punch." On the other hand, the 20 mm weapon can probably fire more rounds in a given time and, for a given weight, the magazine can hold considerably more rounds. A typical application of the M-39 is the F-100A Super Sabre, which mounts four.

The Ford Company recently received three new contracts, one an extension of the M-39 development programme, the second providing for expansion of the weapon engineering and testing facilities at the Rouge factory, and the third—for approximately $1 million—a secret contract for the development of a new weapon for the U.S.A.F.

Dark rumours of a new weapon lead naturally enough to work by the American General Electric Company. In referring to this company's "Project Vulcan," we cannot do better than quote from a recent issue of *General Electric Review*, in which a member of the G.E.C. staff was shown a firing trial of the new development.

"In a long row of garage-like structures where guns are fired into sandbanks, I saw 'Project Vulcan,' an amazing device that has been under development by General Electric since 1948. It is not a gun: as Kirby [G.E.C. representative at Eglin A.F.B., Florida] pointed out, it is designated as a 'firing mechanism.'

"It sat on its mount in the middle of the test cell—squat, stark and simple. The 20 mm shells were fed into its side from a long trough that extended over to one wall of the cell and then up the wall to the ceiling.

" 'It's not like a gun any more,' an armament officer nearby remarked, 'it's like an entirely new animal.' Even though it's simple, accurate, and easy to maintain, feeding problems are 'sticky,' as he expressed it, 'because it's such a greedy creature.'

"I soon saw just how greedy it is. The range safety officer had given the firing run a 'go-ahead,' indicating that the range was clear. At a signal from the officer in charge we backed against the far wall of the hallway that joined the cells. The device was 15ft away. I put my hands to my ears because everyone else did. I watched the weapon; out of the corner of my eye I saw a technician jerk his hand as he closed a switch. There was a shattering roar, and I felt the sound-waves blast across my chest. Then silence and an awed pause. We let our hands drop to our sides and walked forward slowly. In a wooden box to the left of the device was a jumble of cartridge links and spent shell casings. The feeding troughs were empty. I looked down-range: sand and dust were settling in the pit. The test had happened in the length of time it would take you to slowly snap your fingers.

"Kirby pointed out that this device is unlike the Ford-Pontiac M-39 cannon that was originated by German scientists and operates on the principle of the Western six-shooter with its revolving magazine. This device has a yet higher rate of fire—it even surpasses the term 'fantastically high,' as Kirby expressed it—and is based on an entirely different principle."

Altogether, "Project Vulcan" bears little resemblance to conventional cannon. One might deduce from the above account that it has multiple barrels, for barrel life has been, and remains, one of the weakest points of fast-firing cannon. For example, the cyclic rate of fire of the original MG-213C/30 was cut back from 1,500 to about 1,100 r.p.m. solely on this account. Just how such devices as Vulcan will fit into supersonic aircraft is still a matter for conjecture; in fact, with present expenditure biased heavily towards the guided weapon, it may never be needed. W. T. G.

FAIREY

POWER

CONTROLS

Safe ejection

50ft.

500 knots.

LOW EJECTION AT CHALGROVE

To determine a minimum altitude at which a safe ejection is practicable, with their latest Fully Automatic Ejection Seat, the Martin-Baker Aircraft Company conducted air tests at Chalgrove Airfield, Oxfordshire, on 29th August, 1954.

During the tests an ejection was made from a Meteor aircraft flying at 500 knots at the remarkably low altitude of 50 feet. The ejection was completely successful, the main parachute being fully deployed before the dummy alighted without damage.

This astonishing feat was made possible by the employment of two stabilising drogues in tandem, designed to reduce, with acceptable deceleration, the speed of the seat after ejection and then to control the main deployment of the parachute thus eliminating the explosive opening characteristic. This seat was also fitted with the Martin-Baker Patent Barostatically Controlled Time Release Mechanism and Drogue Gun.

With this arrangement automatic separation from the seat after ejection occurs with insignificant loss of height, and safe escapes near the ground are made practicable. No other ejection seat is capable of this performance.

These design features are patented in the principal countries of the world.

Martin – Baker

AIRCRAFT COMPANY LIMITED · HIGHER DENHAM · NEAR UXBRIDGE · MIDDLESEX

Streaming its ribbon tail-braking parachute, the prototype McDonnell F-101 Voodoo, referred to in a paragraph on this page, turns off the runway. This machine is the largest, heaviest, possibly the fastest, and certainly the farthest-ranging fighter in the world.

AIRCRAFT INTELLIGENCE

U.S.A.

Experimental Fairchild-built Avitruc. A Fairchild-built Chase C-123B Avitruc is to be fitted with a Fairchild J44 turbojet of 990 lb thrust at each wing-tip. The installation is connected with experiments in boundary layer control.

Piasecki H-21 Work Horse. This year will see the Piasecki H-21 Work Horse helicopter being put through its C.A.A. certification, and deliveries to commercial operators should be possible in early 1956. Designation of the civil Work Horse will be the PH-42. Gross weight will be 13,300 lb, payload 1½-2 tons, and price 250,000-275,000 dollars, depending on customers' requirements. Power plant will be the Wright R1820-103 (1,425 h.p. for take-off).

McDonnell F-101 Voodoo. Possibly the fastest of all fighters, this very large, long-range escort and "atomic-capability" single-seater, a new picture of which appears on this page, makes extensive use of titanium. This material is used, for example, for fuselage frames, webs, stiffeners, angles and wing-spar fittings.

Bell Helicopter Sales. The sales of Bell commercial helicopters are stated to have climbed, during 1954, 20 per cent above the record figure for the previous year, while total orders for aircraft and parts increased by 32 per cent. The majority of helicopters delivered were of the 47G model (three-seater with 200 h.p. Franklin engine). Additionally the HSL tandem-rotor anti-submarine helicopter is in production, and work is in progress on the XV-3 convertiplane and the XH-13F turbine-powered development of the Model 47.

France

Marcel Dassault Mystère. Three new Mystère developments are reported—the 22, 24 and 26. All are light fighters for interception and ground-attack duties. The 22 and 26 are reported to be single-engined and the 24 twin-engined.

S.N.C.A.S.O. Vautour. In addition to the previously announced production order for Vautours, a pre-production batch of six is being built, and one of these, it is reported, will be powered by Avon RA.23s. The engines of production Vautours will be Atar 101s.

Netherlands

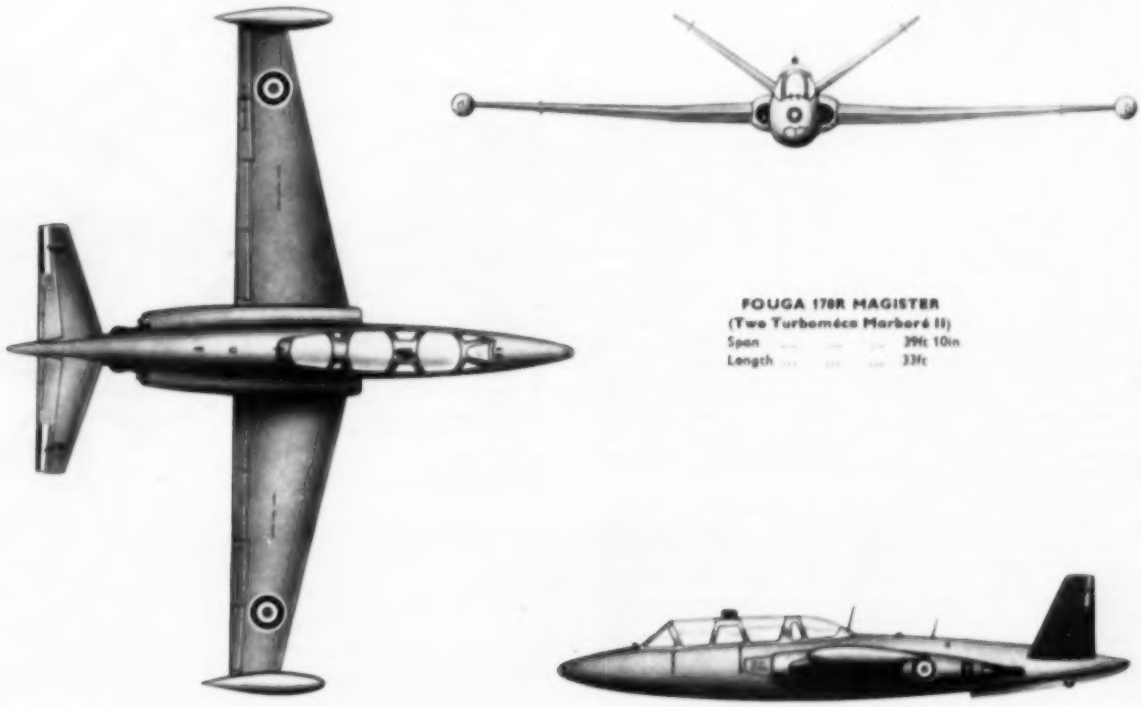
Fokker Jet Trainers. The first Fokker S.14 of a production order of twenty for the Dutch Air Force made its first flight on January 13, piloted by Gerben Sonderman. The aircraft is Derwent-powered, though the prototype S.14 is still flying with a Nene. A Dutch correspondent writes that in NATO circles the S.14 is still considered as "the only suitable jet trainer for a two-stage, all-jet training programme." Serious interest in the S.14 is manifest in Germany, where the type may yet be built under licence. It is also reported that Fokker have a design for a primary jet trainer weighing about 2,850 lb and having side-by-side seating. The project, however, is not regarded as "urgent."

Fokker F.27. The first prototype of the F.27 Friendship twin-jet transport will fly this summer; the second will be used for structural tests; and the third, which should fly about three months after the first, will probably make a demonstration tour of the U.S.A. Preparations for quantity production were announced last week. It is now known that the Friendship will not be exhibited at the Paris Aero Show. Instead, a new interior mock-up will be on view.

Hunter Production. Production in Holland of the Hawker Hunter is proceeding well, and the first Dutch-built machine should be in the air about May. Marks to be built in Holland are reported to be the 4 and 6.

Sweden

Saab Safir. A new series of Saab 91 Safirs is to be produced by the parent company at Linköping. Both the three-seat 91B trainer and the four-seat 91C are involved, though no numbers are given in either case. The reason for this further production is stated to be the increased production capacity of the Linköping factory. All previous 91Bs and Cs were built under licence in Holland. Safirs are in service in 15 countries.

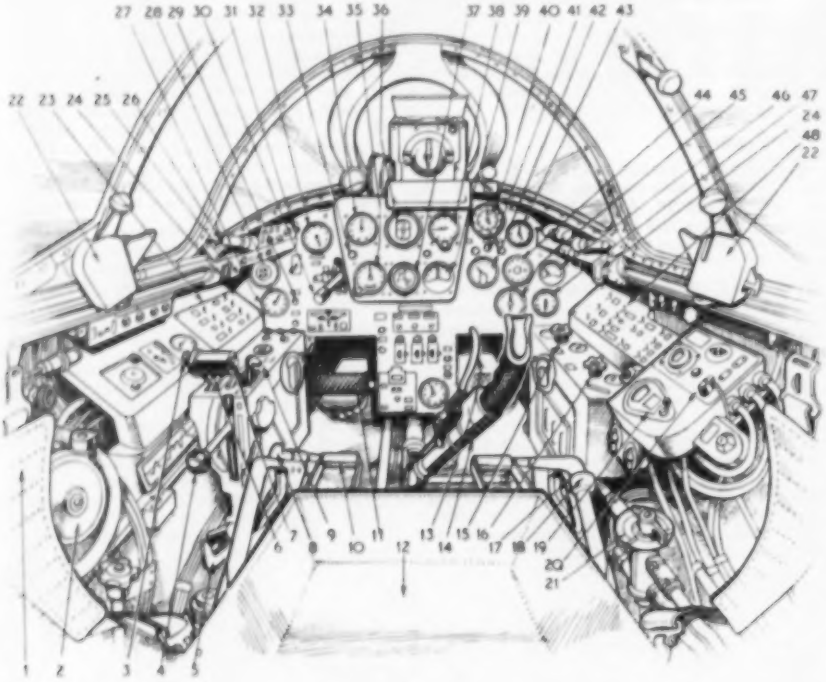


FOUGA 170R MAGISTER
(Two Turboméca Marboré II)
Span 39ft 10in
Length 33ft

Russia I

RARELY can it be asserted with any degree of confidence that descriptions of Russian military aircraft have emanated from a dependable source. On these pages, however, we present a set of drawings of the Mig-15 to which—having regard to their known Russian origin—a very high degree of authenticity can certainly be ascribed. The illustration showing the cockpit is a direct "translation," from half-tone to line, of the original, and while additions—notably armament—have been made to the view of the complete aircraft, and small modifications have been incorporated in the interests of accurate draughtsmanship, this, too, stands essentially as it was received from Russia. Not the least interesting point concerning it is that, whereas no guns appeared on the original, a reconnaissance camera was shown installed as indicated. Our own rendering of the armament is based on authentic information obtained from an actual example of the aircraft. The drawing may reasonably be accepted as evidence that a reconnaissance version of this still-remarkable Russo-Germanic fighter (with its British-type turbojet) has been built.

1 Lap strap.
2 Oxygen.
3 Starter.
4 Flap control lever.
5 "Cables control bar."
6 Power lever.
7 R/T. button.
8 Ejection arming-plunger.
9 Air brake lever.
10 Ejection foot-rest.
11 Rudder pedals.
12 Ejector-seat pan.
13 Brake lever.
14 Control column.
15 Emergency undercarriage release.
16 Emergency flap-release.
17 Ejector-seat handgrip.
18 Canopy jettison.
19 Homing-beam control.
20 R/T. control panel.
21 Cabin-pressure control.
22 Canopy lock.

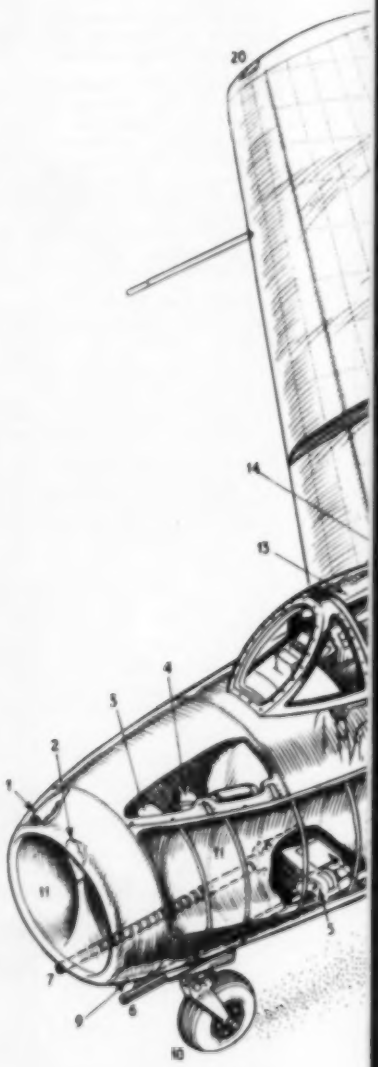


A British fighter-pilot writes: "It is difficult to comment usefully on a cockpit without actually being able to sit in it and assess the space, comfort, range of vision and accessibility of controls. The illustrations of the Mig, however, do convey the impression that the layout of instruments and controls has been given careful thought. The central blind-flying panel is clear, at a good height, and differs from R.A.F. practice only in having two direction indicators (one presumably the homing indicator) and no turn-and-slip needle. Engine instruments and clock are well grouped to the right of the facia board and Machmeter and oxygen controls to the left. The gyro gun-sight follows the British pattern, but there is probably insufficient room to retract it for improved visibility. No trim-wheels are apparent, so one presumes the use of button-controlled trim. The 'cables control bar' (5) suggests manual reversion or control-gearing. Starter button, throttle, 'press-to-transmit' switch and speed-brake lever are well grouped to the left, while those unhappy bedfellows, undercarriage and flap lever, are well separated. Layout of switch consoles to right and left, and the positioning of the wheel and flap emergency controls, appears good, though switches could be knocked by the pilot's forearm.

"The hooks by which the lap straps can be hung up out of the way when the pilot is not in the aircraft should be most useful aids to a quick strap-in and getaway for a scramble. The sitting position seems good, with the feet well up for resistance to g, while the hip-level ejector-seat and hood-jettison controls should make for easy escape. The small size of head-rest improves rearward view. The seat, however, appears to be only of the semi-automatic type. Finally, one wonders how much the straight, unjointed control column might tangle with the pilot's knees, and how much room his shins would have below the panel."

23 Port electrics panel.
24 Canopy release lock.
25 Cockpit light.
26 Ultra-violet light.
27 Oxygen pressure.
28 Oxygen flowmeter.
29 "Use oxygen" warning.
30 Undercarriage lever.
31 Cabin light switches.
32 Machmeter.
33 "Signal lamp."
34 A.S.I.
35 Altimeter.
36 Artificial horizon.
37 Compass.
38 Rate-of-climb indicator.
39 Course indicator.
40 r.p.m.
41 Fuel warning lights.
42 "Gas indicator."
43 Clock.
44 Fuel (paraffin) indicator.
45 Oil and fuel temperature gauge.
46 Voltmeter.
47 Fuel pressure.
48 Starboard electrics panel.

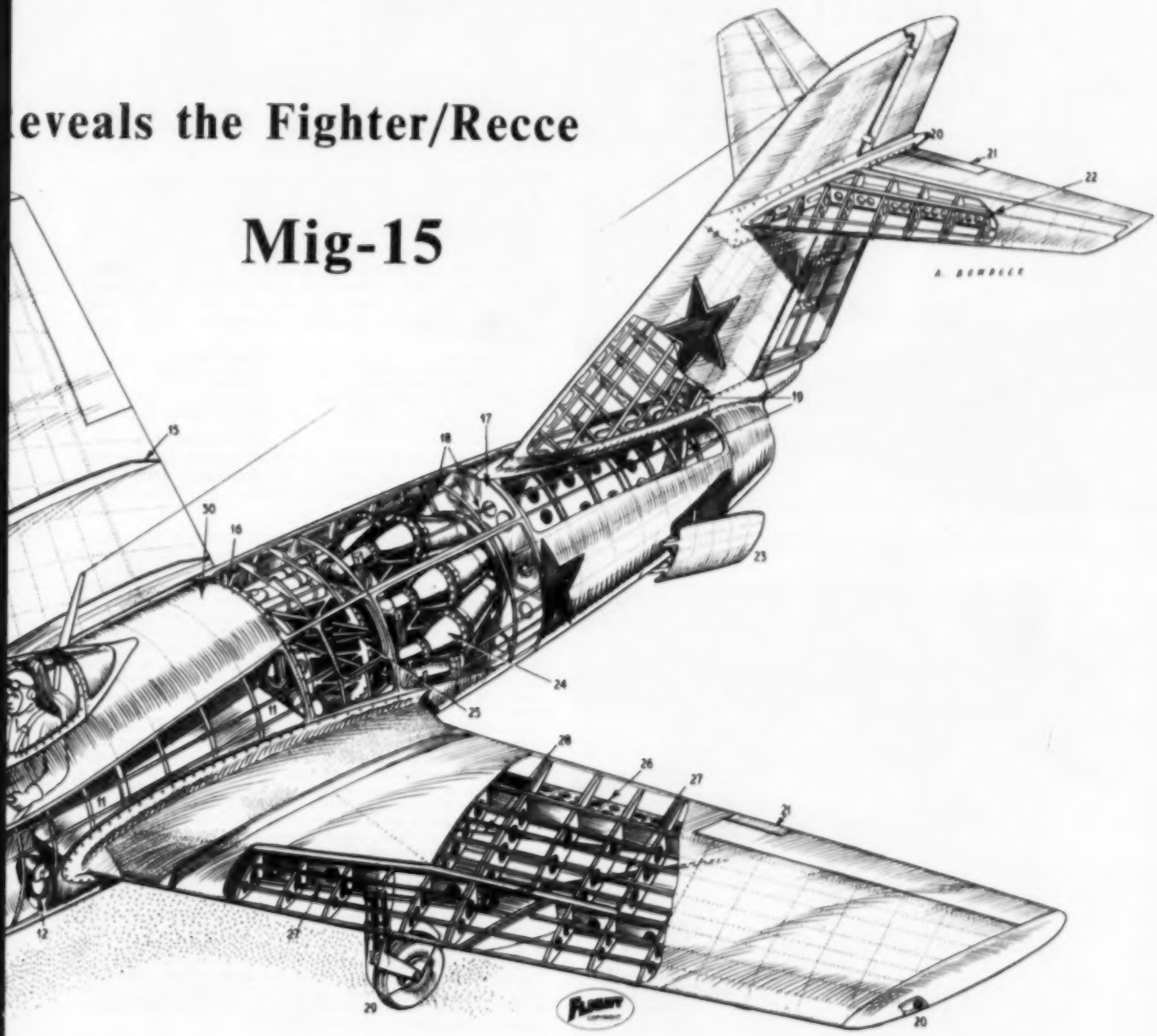
Ejection-seat sequence. Shown in the inset circles



the various movements of the seat-actuating handgrip and canopy-jettison knob (8 and 18 in cockpit drawing).

]eveals the Fighter/Recce

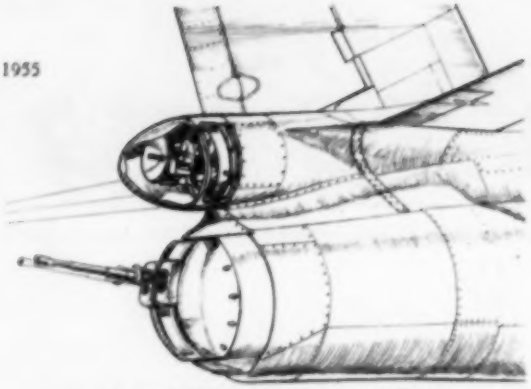
Mig-15



1 Combat camera.
2 Landing light.
3 Accumulator.
4 Oxygen bottle.
5 Gun pack, comprising:
6 Twin 23 mm guns.
7 Single 37 mm gun.
8 Ammunition.
(The whole pack is cable-lowered for servicing.)
9 Blast-protection panel.
10 Forward-retracting nosewheel.
11 Bifurcated engine-air intake.
12 Camera.
13 Pressurised cockpit. Sliding canopy.
14 Ejector seat.
15 "Fences"—two on each wing.
16 Transport joint (plenum chamber front-frame).
17 Plenum chamber rear-frame.
18 Rudder cables.
19 Fin main-spar.
20 Navigation lights.
21 Trim tab.
22 Single-spar tailplane.
23 Air brakes.
24 Turbojet (Nene development).
25 Engine bearers.
26 Plain flaps (down).
27 Aileron control.
28 Aileron trim control.
29 Inward-retracting main undercarriage.
30 Fuel.

AIRCRAFT ARMAMENT PART 2

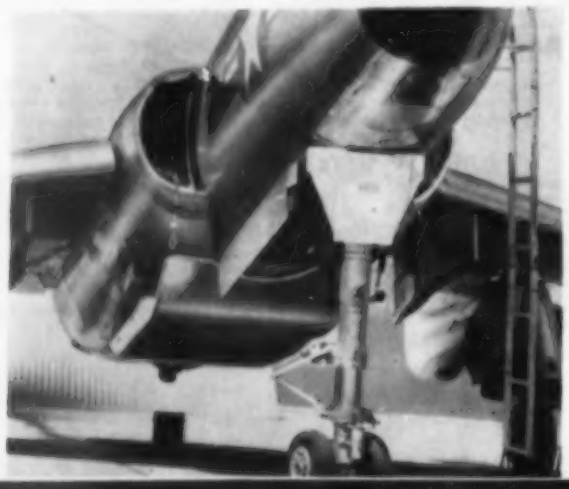
MISSILES AND PROJECTILES



General Electric tail turret, with two 20 mm guns, on Boeing B-47. (Search-radar housing shown sectioned.)

Incomplete tail-gun emplacement of the Boeing B-52 Stratofortress—the world's largest bomber. (Intended armament is four 20 mm guns.)

(Above) Retractable launcher for Mighty Mouse R.P.s on the North American F-86D. (Below) Mighty Mouse pack on Chance Vought F7U-3.



THOUGH the shadow of the hydrogen bomb lies grimly across the political and social scene, the technical particulars of this weapon are still obscure. Indeed, little of a definite nature is known of even the earliest forms of "special weapon," and in consequence the present section of our review is necessarily out of balance. It must, however, be appreciated that more-or-less conventional air armament will hold a place for years to come, and with that in mind we have assimilated available information under these headings:—

Gun turrets	Guided bombs
Air-to-air-rocket projectiles	"Special weapons"
Air-to-air guided missiles	Torpedoes
Air-to-surface rocket projectiles	Sea mines
Guided anti-tank missiles	Depth charges
Air-to-under-water missiles	Napalm
Unguided bombs	Anti-personnel darts

Readers seeking a general survey of guided missiles and their evolutionary background are confidently referred to *Development of the Guided Missile*,* by Kenneth W. Gatland, F.R.Ae.S.

Gun Turrets. Though the U.S.A.F. and U.S. Navy have retained defensive gun turrets on their post-war multi-engined bombers, and Russian policy is likewise conservative, defensive guns on British bombers have been entirely—and, it seems, finally—abandoned. This policy, initiated with the Mosquito, is rendered possible on the Canberra, Valiant, Vulcan and Victor not by high speed alone, but by very high operational ceilings and exceptional standards of manœuvrability at altitude—these last qualities being the dividends paid by moderate wing and thrust loadings. Tail-warning radar is mandatory on all bombers pretending to the title "modern," while countermeasures continue in demand.

Standard defensive armament of the Boeing B-47 Stratojet medium bomber is a remotely controlled, unmanned General Electric tail turret mounting two 20 mm guns. Associated with this turret is a search-radar installation, which is switched on in a danger zone so that, when a pursuing fighter shows itself on the screen, it is automatically tracked. Having approached within range, it is engaged, again automatically, by the B-47's guns. The more massive B-52 heavy bomber has a somewhat similar arrangement (though, in this case, allowing for the position to be manned), and the armament consists of four 20 mm guns.

The U.S. Navy's Douglas A3D and its U.S.A.F. counterpart, the B-66, is defended, like the B-47, by two remotely controlled 20 mm guns in a tail installation, and emp'acements of a generally similar pattern have been identified on Russia's I1-28 straight-wing, twin-jet bomber, on the swept-wing, twin-jet Badger, and on the four-jet, swept-wing Bison.

Some years ago it was reported that experiments were to be made with defensive guided-missile installations on a Convair B-36 heavy bomber, but the outcome of trials (if, indeed, they proceeded as planned) has not been divulged.

Air-to-air Rocket Projectiles. Under this heading are considered those weapons which have stemmed from the 2in R4/M, developed by the Germans in the late war. The R4/M was the first specialized air-to-air rocket and weighed 7¼ lb, with an explosive head of 1 lb.

Before the war's end, brief though remarkable successes were achieved against Boeing B-17 bombers.

The post-war American counterpart is the 2.75in folding-fin Mighty Mouse, developed by the Naval Ordnance Test Station, Inyokern, California. Generally similar is the Aeromite, developed by the Aerojet Corporation, but no corresponding weapon is

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LONG

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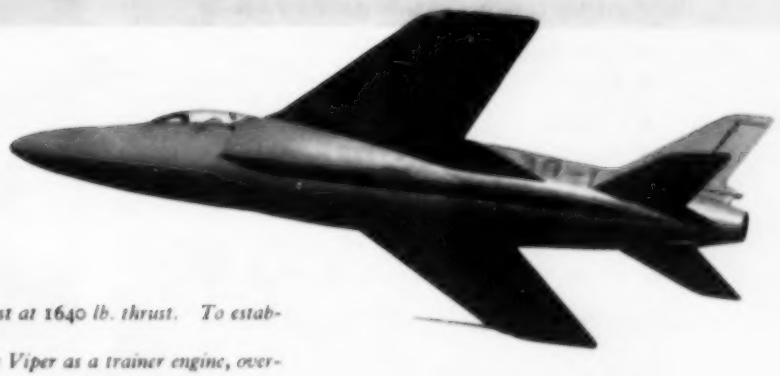
THE

VIPER



...versatile VIPER

The excellent progress being made with this engine has been demonstrated recently by the performance of the Hunting Percival Jet Provost trainer and the Folland Midge light fighter prototype, and also by the recent successful official type test at 1640 lb. thrust. To establish the Viper as a trainer engine, overriding emphasis is placed on simplicity, reliability, fool-proof operation and the longest possible life between overhauls. Experience in the Midge and other aircraft is also demonstrating the engine's capability of operating at high speeds and altitudes.

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MISSILES AND PROJECTILES . . .

A salvo of electronically aimed, automatically triggered, Mighty Mouse R.P.s leaves the wing-tip launchers of a Northrop F-89D.

employed by any Commonwealth air force except the R.C.A.F. The Mighty Mouse attains a velocity of over 2,900ft/sec and its warhead is said to rival, in destructive effect, a 75 mm shell. Illustrative of its potency is the bringing down of a Boeing DB-17, with its crew, by a single accidental hit from an F-86D which had mistaken the DB-17 for the radio-controlled target which that aircraft was controlling.

In Switzerland, the Oerlikon organization has developed various forms of air-to-air/air-to-ground rocket. The first to become operational is an 8 cm (3.15in) weapon, about 2ft long, weighing 22 lb, of which 2.2 lb is explosive. There are three versions: an H.E. pattern with contact nose-fuse; an armour-piercing version, having a percussion fuse in the base of the hollow explosive charge; and a practice rocket with dummy warhead. Projectiles of this type, to a total of 24, are carried by Swiss Air Force Vampires on staggered tandem racks. "All-burnt" velocity is 2,750-3,100ft/sec.

A retractable launching device for a Mighty Mouse battery is a key feature of the North American F-86D Sabre single-seat all-weather fighter. Twenty-four projectiles are carried in a tube-filled ventral discharger, which, at the appropriate range, is hydraulically extended from the fuselage by a circuit in the Hughes fire-control system. The R.P.s are then "rippled" electrically in a predetermined sequence. The discharger can be lowered, a salvo of twelve rounds fired, and the discharger retracted again in the space of one second. As the tails of the projectiles leave the launcher their velocity relative to the aircraft is about 100 m.p.h., or about 500 m.p.h. when passing the nose. It is necessary that the "Mice" should follow a path governed solely by the direction in which the aircraft is pointing at the moment of release, and not by the relative wind. For this reason their fins remain locked until clear of the aircraft, so that "weather-cocking" in the initial stages is reduced almost to zero. Little of the propulsive gas from the rockets is swallowed by the engine air intake, although, being of the "beard" type, this is closely situated to the line of fire.

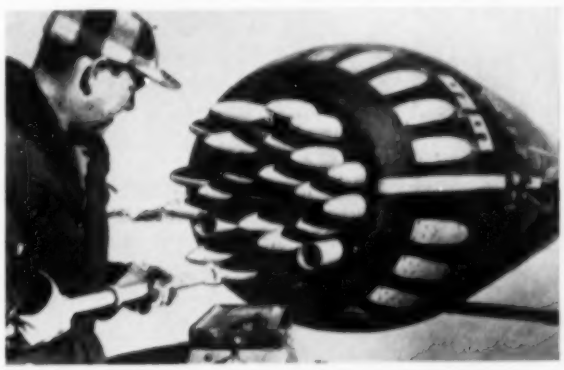
Two under-wing "packs," of approximately aerofoil section, and each containing 45 Mighty Mouse rockets, are a possible load for the North American F-100 Super Sabre.

Like the F-86D, the Chance Vought F7U-3 Cutlass has a ventral Mighty Mouse launcher, though this differs in design. The complete assembly (see photograph) can be reloaded repeatedly after expending its missiles, or can be detached in a few minutes. The muzzle door retracts before the rockets are fired, and the missiles are triggered off by the door itself when this is fully retracted. Capacity is believed to be 32 rockets, loaded in pairs in 16 tubes. When firing has ceased the door is closed automatically. For strike operations additional Mighty Mouse packs can be carried under the wings.

The most powerfully armed fighter in operational service is the Northrop F-89D Scorpion, which carries 104 Mighty Mice in massive wing-tip pods. These, the makers claim, confer improved dispersion, since two sources of fire power are used instead of a single concentration, as on the F-86D; moreover, the firing of the rockets does not interfere with the vision of the crew at the critical moment of interception, and engine-air intakes are not exposed to smoke and debris from the rockets. The projectiles can be fired in a single salvo or in groups, enabling the Scorpion to make as many as three passes at a single target or to attack three separate aircraft. As on other American rocket-armed fighters, electronic aiming and triggering equipment is standard. The makers have said that the rockets "fan out in overlapping patterns like huge shotgun blasts to blanket an area of sky as large as a football field."

The F-94C version of the Lockheed Starfire two-seat all-weather fighter is another U.S.A.F. fighter with all-rocket armament. In the nose, around the radar, is a ring of 24 Mighty Mouse or Aeromite firing tubes, and projecting about 6ft from the wing leading edges are two pods each containing 12 more projectiles of the same type. Thus, 48 rounds are carried in all. The firing ports in the fuselage nose are normally covered by retractable panels which, immediately before firing takes place, recess into the fuselage. The 12 podded rockets can be fired in less than a quarter of a second, and their housings have frangible Fiberglas nose covers, which disintegrate outwards under gas pressure an instant before the rockets leave. Maximum speed is lowered by only 4-8 knots by the removal of the covers. Machine-gun batteries can be mounted as alternatives to the pods.

Collision-course tactics are regularly employed by the F-86D and F-94C: that is, they approach a bomber from abeam instead of by the traditional stern-chase method, which would bring them within the accurate field of fire of the bomber's defensive armament. The technique is as follows: First the fighter is positioned by normal G.C.I. control and is manœuvred relative to the bomber to a point where its A.I. radar registers contact; this occurs at a range of about 25 miles. Thereafter the interception is controlled by the crew—in the case of the F-86D, by the pilot alone. He closes in towards the target until, by one means or another, he can identify it, and then locks his fire-con-



(Above) An armourer, using a special tool, in process of loading 52 Mighty Mice into one of the Scorpion's wing-tip pods. Below is a remarkable panoramic view illustrative of the Scorpion's tremendous fire power. To secure it three tail-mounted cameras were triggered simultaneously.

Showing how the ring of Mighty Mouse tubes on the Lockheed F-94 Starfire is exposed for firing. Twenty-four of the projectiles are carried in the circle of tubes and others in wing-mounted "pods."

MISSILES AND PROJECTILES . . .

trol mechanism on to it. All subsequent computing is then automatic, and the weapons themselves are automatically launched. Immediately after firing the pilot turns hard away to avoid collision.

The 9ft × 45ft plastic-fabric banners for collision-course practice are towed by North American B-45 Tornado bombers, and are fitted with spinning metal discs to give the fighter's radar something to "lock on." Notwithstanding the automatic nature of the system, during tests at Yuma, Arizona, last year, hits were scored on only about 27 per cent of the sorties. Even so, one Sabre pilot placed all 24 of his rockets on the target at the first try.

The Mk 4 variant of the Avro Canada CF-100, as now in service with the R.C.A.F., has wing-tip Mighty Mouse pods and a third pack, holding some 48 projectiles, which is retractable into the fuselage. When the podded rockets have been discharged the pods themselves are normally jettisoned, thereby improving rate of roll by some 20 deg a second.

Forthcoming French fighters will have fuselage-mounted Matra "automatic rocket magazines" with a capacity for 32 or 55 Brandt or Mighty Mouse projectiles, and external containers for 19 rockets are also being developed.

Magazine-fed rocket dischargers have been tested in recent years by the U.S.A.F. (Lockheed F-80) and U.S. Navy (Douglas Skyraider), the latter with belt-fed, spin-stabilized 5in HVARs. The latest development in this direction now on test in the U.S.A. (at the Air Research and Development Command's Armament Centre, Eglin Air Force Base, Florida) is the T-110 launcher, for which two Northrop F-89 Scorpions are being used as flying test-beds. Though no production-type Scorpions are intended to have the new armament, the test-beds have two T-110s mounted in the forward nose section.

The appearance of the installation, which was developed for the U.S.A.F. by the Armour Research Foundation of Chicago, Illinois, is shown on page 117. Tests are said to have proved that the launcher is "compatible to the airplane and highly effective from a fire-power standpoint."

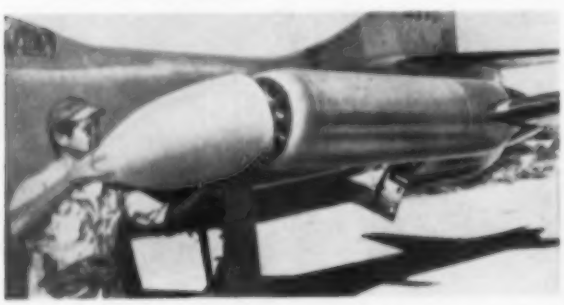
The new Scorpion installation recalls the experimental fitment of a revolver-type launching system on a Lockheed F-80 Shooting Star, wherein six 4.5in finned rockets were loaded in a "cylinder" and fired through a single "barrel." The project was abandoned because insufficient rounds could be provided to justify the bulk and weight of the "gun." Reference to other experimental launching systems is made under "Air-to-Surface Rocket Projectiles."

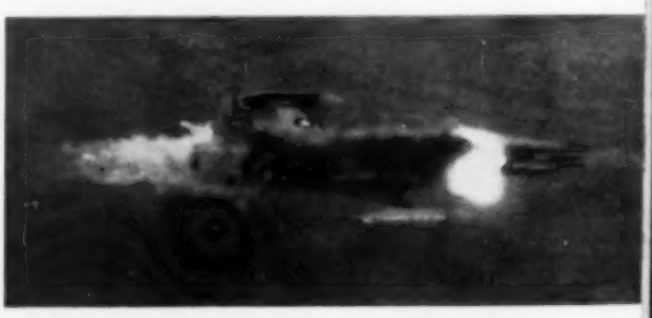
Air-to-Air Guided Missiles. As distinct from the Mighty Mouse type of unguided, impact-detonated projectiles, these missiles can be classed as (1) unguided, with target homing; and (2) radar-guided—with or without target homing. For the present at least they are carried beneath, or at the tips of, the wings of fighters, though internal stowage is feasible—may, indeed, become mandatory as speeds increase unless the missiles are of very fine aerodynamic form, or are very carefully faired.

Homing devices can utilize the energy radiated or reflected by the target, e.g., heat, noise, wake, infra-red radiation or static electricity, but one difficulty common to all self-guidance systems is that of achieving rapid change in direction of a supersonic missile to give it the "intelligence" and persistence to pursue the target, no matter how the latter may twist and turn to avoid interception. In the self-homing device is a "brain unit," capable of making high-g turns (up to 20g in present missiles) and of operating with split-second timing and with instantaneous control entirely beyond human capabilities. Because of the high inertia loads involved, radio valves, actuators and other items of equipment have had to be redesigned for this specialized task.

A device is required to ensure the detonation of the warhead at a certain proximity to the target, a good example being the British "VT" radio-fuse as used in A.A. shells. Other methods, among them magnetic, photo-electric and acoustic systems, have been tried. Destruction of the missile in the event of a miss must also be ensured by the incorporation of a safety exploder. The ultimate complication may be a device, similar in principle to the familiar I.F.F., to turn away or destroy a missile which attempts to "home" on a friendly aircraft.

Of British air-to-air missile developments nothing of a detailed nature can be reported, though the photograph of a Meteor N.F.11





(Above) Placing the muzzle cap on a 12 × 2.75in Mighty Mouse pod on a Starfire. (Upper right) A Starfire launching its nose-mounted Mighty Mice. (Below) Similar projectiles being discharged from a wing-tip pod of an Avro Canada CF-100.

launching a sizeable missile was officially released as long ago as August 1953.

The missile itself is of comparatively small dimensions and has solid-propellant boosters attached forward of the wings. It has been suggested by Mr. Gatland that it would not contain a homing unit, the electronic equipment being kept as simple as possible. Should this surmise be correct, the "brains" would have been divided between the launching aircraft and the missile itself. Probably in the Meteor's nose there is a radar unit projecting a narrow angle beam along the line of flight. This would be locked on the target at a range of several miles, and at the most favourable moment the missile would be discharged along it. The missile would therefore be of the class known as "beam-riders" and would itself carry a receiver and servo controls to centralize itself in the guiding beam. At a predetermined distance from the target the warhead would probably be detonated by a proximity fuse. A further refinement might be to employ "semi-active" homing, i.e., the launching aircraft would carry a radar transmitter and the missile would guide itself by target reflections.

The final step would be to put the entire "brains" into the missile by building a radar scanner into the nose in order to locate the target and make all corrections necessary to achieve a hit.

The photograph previously referred to accompanied a statement by the then Minister of Supply entitled *Progress of British Guided Rockets*, from which this paragraph is taken: "In addition to missiles fired from the ground or from ships, we have reached an advanced stage in the development of guided rockets to be launched from fighter aircraft. These will increase the killing power of our fighters many times over, and will enable them to engage an enemy bomber from a distance beyond the range at which it can defend itself with any conventional aircraft gun."

Since that time a Supermarine Attacker has appeared in public with two sturdy under-wing carriers, supposedly for missiles, and printed references have been made to a Supermarine Swift and English Electric Canberras carrying guided weapons, likewise beneath their wings. That the Hawker Hunter, Gloster Javelin, D.H.110, Supermarine 525 development and English Electric P.1 will, in certain forms at least, be missile-armed, is a certainty.

Among British firms engaged in missile development (not necessarily air-to-air) are Armstrong Whitworth, Bristol, de Havilland, E.M.I., English Electric, Fairey, Vickers-Armstrongs and Sperry.

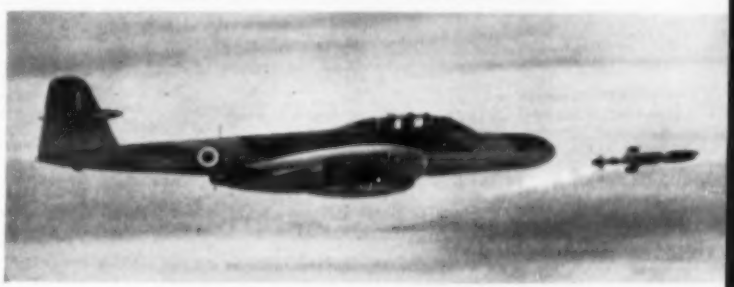
It is reported in America that British fighters—the Gloster Javelin first, and others later—will be armed with a de Havilland air-to-air missile which homes on to sources of infra-red (i.e., heat) radiation. Heat, it is pointed out, forms part of the light spectrum, and devices which measure light can, if they are sensitive enough, measure heat radiation. Since they respond to heat they are less effective in sunlight, or in the presence of multiple heat sources; but by their very nature their guidance systems gain increased accuracy as they approach their targets.

A guidance system based on detection of infra-red rays has obvious limitations. It has a short range (about ten miles at night and less in daylight), and artificial "targets" (i.e., infra-red searchlights) could throw the missile off course. A writer in *American Aviation* is of the opinion that heat detectors may prove extremely valuable for specialized conditions—for instance, intercepting a supersonic missile of predominantly plastic construction fired on a ballistic trajectory. If developments permit future infra-red systems to home on heat caused by the skin friction of supersonic missiles, or to gain sufficient signal strength from a head-on approach of another missile or aircraft (from the radiating exhaust heat), heat detectors could, it is considered, prove of unique value.

In Canada a very promising air-to-air weapon is under development. Most of the initial theoretical study underlying the design was carried out with electronic analogue computors, which examined the behaviour of a hypothetical missile tracking a hypothetical target. The work was largely undertaken at the Canadian Armament Research and Development Establishment, Valcartier, Quebec, though design of the weapon's airframe was entrusted to Canadair, Ltd., at Montreal. Some associated electronic work was the responsibility of Westinghouse. Last August most of the components and systems were known to be in a reasonably advanced state of development; the basic shell had been launched from the ground, using rocket boosters, and an air-launching had also been achieved. The weapon is likely to see service on Sabres and Avro Canada CF-100s, and may be succeeded by more advanced types for employment from the C-105.

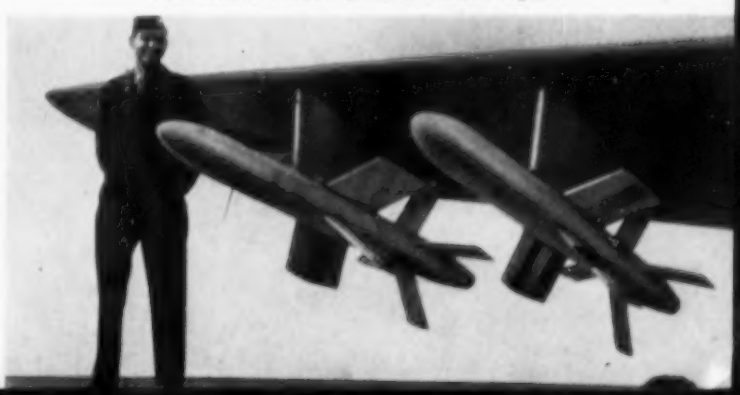
Among early air-to-air missiles developed in America was the Ryan Firebird (XAAM-A-1), produced in small quantities during 1950 and proved in tests at Holloman Air Force Base, New Mexico, during 1951-52. The Firebird was radio-guided from the launching aircraft to the general proximity of the target and was thereafter self-homing; the nose contained a proximity-fired destructive charge. Propulsion was by a solid-fuel bi-propellant

Experimental installation of T-110 rocket launchers on a Northrop F-89 Scorpion. Tests have been conducted at the U.S.A.F. Armament Centre, Eglin A.F.B.



The officially approved photograph above shows a pair of guided missiles being experimentally launched from an Armstrong Whitworth Meteor N.F.11 night fighter. This is the only photograph of a British air-launched missile yet cleared for publication. Below is a possible missile-carrier on a Supermarine Attacker of the Royal Naval Air Fighting Development Unit.

(Below) Ryan Firebirds emplaced on a U.S.A.F. fighter.



Sparrow I guided missiles on a Douglas F3D Skyknight of the U.S. Navy. (Below) Matra M.04 air-launched missile, weighing 920 lb.

Project Hot Shot and dating from 1947, when the U.S. Navy assigned to Sperry the full responsibility for creating an entirely new air-to-air missile system. Embodied in this missile are features of more than a hundred different designs tested during a seven-year period. Production Sparrows are said to be beam-riders with terminal homing, but Sparrow I (XAAM-N-2) and Sparrow II (XAAM-N-3) are known to differ in guidance systems, and Sparrow V is made by Raytheon. Reference to a Sparrow III (XAAM-N-6) has appeared in the American press. All types are 8ft 3in long but less than 6in in diameter and use a solid propellant. Speeds up to Mach 3 and ranges of up to five miles are reported. Gross weight is 280 lb. The airframes are Douglas-built and have folding fins for storage and shipment. For the early air-launching of Sparrows the U.S. Navy employed a Douglas F3D Skyknight all-weather carrier-borne fighter, with two of the missiles under each wing on pylon mountings.

For the U.S.A.F. the Hughes Aircraft Company has developed the Falcon, existing or planned in three versions: Falcon I (formerly F-98, now GAR-1), Falcon II and Falcon III. (Falcon II differs from Falcon I in its guidance system.) This weapon uses a solid propellant to achieve Mach 3 speed and has automatic tracking radar. Glass fibre-reinforced phenolic plastic is extensively used in the body and wings to withstand a 500-deg temperature.

The first fighter specifically designed to be armed with automatically launched Falcons is the Convair F-102 delta-wing interceptor, from which initial trials, using a specially developed Hughes fire-control system, are likely to be made this year. Meanwhile, to determine the stability of the F-102 as a firing platform, dummy firing tests (without the fire-control equipment) will be undertaken by Convair. A "second source" named for Falcon production is Philco, which company is also building, to the designs of U.S. Navy Ordnance, the air-to-air Sidewinder I (XAAM-N-7) and Sidewinder II. Of these weapons little is known except that they are used in conjunction with a three-pod

(Below, left) Tier-stowed 60 lb R.P.s on Supermarine Swift F.4. (Lower, right) de Havilland Vampire with concrete-headed practice R.P.s.

MISSILES AND PROJECTILES . . .

rocket, initially boosted by a separate bi-propellant rocket; length was 7ft 6in; diameter 6in; span of the cruciform wings 3ft; and the weight 600 lb. The Martin Oriole (XAAM-N-4) was a ramjet-powered missile for the U.S. Navy, having a speed of Mach 3, a range of some 20 miles, and a gross weight of 1,500 lb. Mention may also be made of the Bell Meteor for the U.S. Navy, propelled by a liquid-fuel rocket, weighing 500 lb (warhead 25 lb) and having Mach 3 performance.

Today the U.S. Navy has in production at Sperry's Farragut plant, in Bristol, Tennessee, the Sparrow I, originally designated

installation at the wing-tip. One pod is mounted above, one below and one outboard, giving a cruciform section when viewed frontally.

It is appropriate here to take note of the Boeing F-99 Bomarc which, though generally described as a pilotless interceptor, must be considered, for the present at least, as an ordinary ground-to-air missile. It does, however, foreshadow the possible development of pilotless fighters, which would carry their own air-to-air missiles and discharge them automatically before being guided back to earth for recovery, or descending by parachute.

Among French air-to-air missiles is a Matra product, a prototype of which was tested during 1952 over the Sahara. The

(Lower, left) Thunderjet being loaded with thirty-two 5in HVARs at Eglin A.F.B. (Right) Thunderstreak with twenty-four 5in HVARs and JATO.

Staggered installation of Oerlikon R.P.s on Swiss Air Force Mustang.

Republic F-84E with two Tiny Tim rockets and twelve HVARs.

S.E.2418 Grognard was to carry two such weapons, each weighing 1,764 lb, one under each wing. The Matra M.04 has been described by the makers as a two-thirds-scale model of a projected anti-aircraft weapon, but is apparently considered as an air-to-air weapon in its own right. Launching weight is just over 1,000 lb, velocity 1,610ft/sec, and a thrust of 2,756 lb is available for 14 seconds. In the air-to-air application there is no booster.

Under development in Switzerland is another Oerlikon high-explosive projectile, with proximity fuse. In this weapon the warhead includes a miniature turbine-generator, driven by the propulsive gases, to provide power for the tiny radar instrument which continuously measures the distance of the target and detonates the warhead at lethal range.

Air-to-Surface Rocket Projectiles. Worth-while targets for these unguided weapons are surface vessels and submarines, motor transport, pontoon bridges, radar installations, locomotives and tanks—though it has been made clear at official demonstrations that the infantry themselves have more accurate anti-tank weapons. Certainly the fighter/bomber finds an isolated tank an extremely difficult target to pick off, although good results can be achieved by a direct hit with a shaped-charge head. A miss by one or two feet might damage a track. The NATO specification for a light ground-attack aircraft calls for twelve 3in rockets as a possible external load.

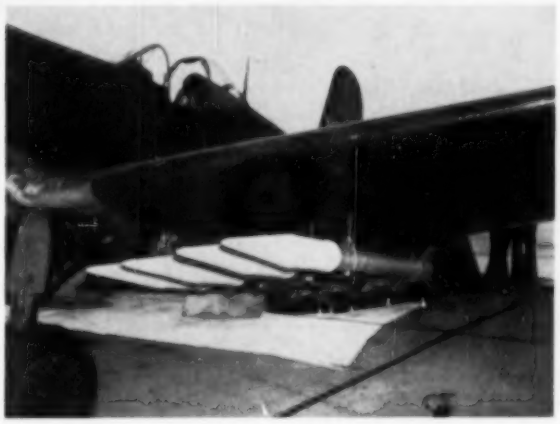
The standard 60 lb H.E. rocket projectile in British service is generally effective at a range of 500-1,000 yards, and the delivering aircraft dives from 3,000-4,000ft, takes up an angle of 20-35 deg, and releases 800-1,000ft above ground level. The 60 lb head is the largest in normal British service, though the three-motor Triplex pattern, with 180 lb head, and the seven-motor Admonitor (250 lb head) were available after the war. The Supermarine Attacker could handle four R.P.s each weighing 300 lb. Napalm-filled heads were developed for the Royal Australian Air Force and used with limited success from Gloster Meteor 8s in the Korean campaign.

American counterpart of our own 60 lb R.P. is the Holy Moses HVAR (High Velocity Aircraft Rocket) of 5in diameter, weighing 140 lb, 6ft long, and attaining a maximum velocity of about 1,350 ft/sec. Destructive effect approximates to that of a 5in artillery shell. A special R.P., developed under a Korean-war "crash" programme at Inyokern for use against armoured vehicles, ships, and concrete and earth fortifications, was the 6in Ram, using a shaped-charge head, with—apparently—the standard HVAR propelling motor.

A heavier U.S. Navy store is the 11.75in Tiny Tim, 12ft long and weighing some 1,284 lb. This weapon has the hitting power of a 12in shell and will penetrate 3ft of reinforced concrete. Velocity (exclusive of the speed of the launching aircraft) is 800-900 ft/sec, and thrust—derived from four 40 lb solventless extruded ballistite grains, discharging through 24 nozzles—is 30,000 lb for one second.

When the Tiny Tim was first test-fired it was swung clear on a displacement yoke, which thereupon retracted. Nevertheless, aircraft returned from firing trials with their undersides badly burned by the 50ft sheet of flame from the rocket propellant. It was also found that the displacement-yoke system entailed a delay, as the rocket swung down, which could cause serious inaccuracy. Turbulence, moreover, caused fore-and-aft instability, and eventually a lanyard dropping-system was developed. The first trial with this equipment led to disaster, for the rocket blast so damaged the aircraft tail surfaces that a steep dive was initiated, from which the pilot was unable to pull out. Thereafter a distance of 16ft was specified before the lanyard fully paid out and the round fired.

A lengthy development programme for spin-stabilized rockets —wherein the exhaust nozzles are slightly offset to cause rotation in flight, like that of a bullet—has been followed in America. Initially two launcher tubes were installed at Inyokern in the nose of a PBJ Mitchell, and thereafter two improved types were tested, one feeding the exhaust flame downward below the wing, and one, located within a fuselage, which necessitated the provision of closed tubes. The first type, fed by 38 belt-fed rockets stored in the wing, was tried out by the U.S. Navy in a Douglas Skyraider,

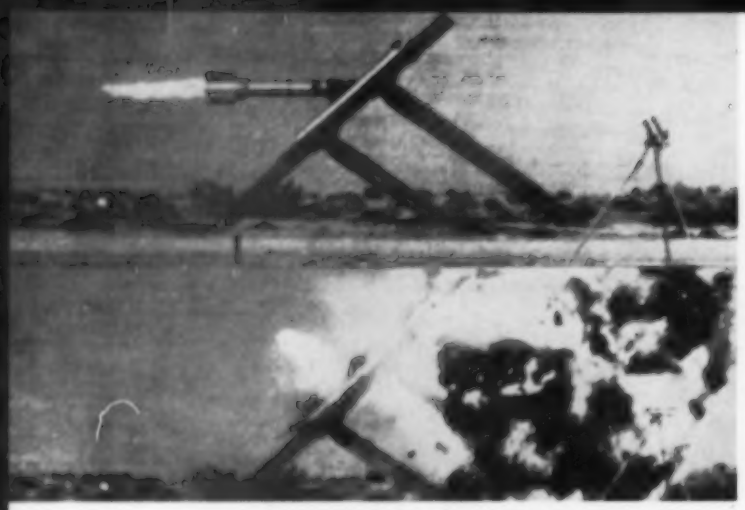


Four Ram anti-tank R.P.s on a Chance Vought F4U.

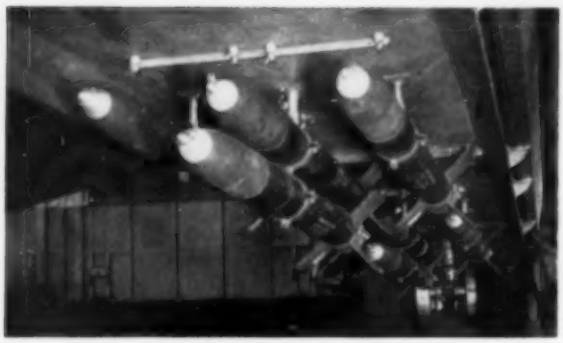
but it was found that the flames badly seared wing under-surfaces. The closed-tube system led to that already described for the F-94 Starfire, and though initial difficulties were encountered with rocket exhaust fouling the intake air for the turbo-jet and causing "flame-outs," it has subsequently been reported to have proved successful.

In the U.S. Navy the 2.75in Mighty Mouse has been used as an air-to-surface weapon from two types of "pod" container, holding seven and 19 rounds respectively. These pods, which have streamlined frangible nose and tail caps, and are jettisoned after firing, are made of cardboard impregnated with plastic, and the rockets are stored in them ready for fitment on the aircraft. For night ground attack in Korea a standard Skyraider load was six 7-round pods, one 500 lb and three 250 lb bombs, and four flares, in addition to 800 rounds of 20 mm ammunition. A possible Skyraider load is fourteen 19-round pods, giving a fire power of 266 rounds.

Special-purpose R.P.s, apparently related to the Ram, on a Grumman Panther of the U.S. Navy.



Firing tests of the 11.75in Tiny Tim rocket projectile.



Mounting of 5in HVARs in Martin rotary bomb-bay of XB-51.

MISSILES AND PROJECTILES . . .

A 66 lb rocket is known to be a standard French weapon and two others are designated "4-90 No. 2" and "120 C.C. No. 2." A heavy rocket—5-*pouces*—weighing over 140 lb, is also available. A special 9 lb anti-personnel rocket has been developed in France since the war and some 200 of these weapons could be carried by such aircraft as the S.E. Grognard or S.O. Vautour. A unique launching device, permitting discharge at the rate of 1,800 rounds a minute, has been flight-tested on Grognard prototypes. In the course of trials, incidentally, it was discovered that the plastic rocket-firing terminals, weighing only an ounce or two, made considerable dents in the heavy-gauge leading-edge skin of the low-placed tailplane. It was realized that jettisoning even such small parts at high speeds could be dangerous, and a new type of rubber terminal had to be developed.

Guided Anti-tank Missiles. In addition to standard types of air-to-ground rocket projectile, a specialized guided weapon has been developed for use with the Potez 75 "tank-stalker" (see *Flight* May 14th, 1954). Employment of this weapon from helicopters is also foreseen. The missile itself is wire-controlled and is a development of the French SS-10 anti-tank weapon, specimens of which have been acquired for U.S. Army tests. (The SS-10 is a finned missile, stabilized by a high-speed gyro and controlled from an optical sight by electrical impulses transmitted through wire to spoilers on the fins. Upon impact the sight is automatically re-set for the next run).

Air-to-Under-Water Missiles. Of these weapons—inspired by German investigations and hastened in development by the menace of the submarine—the most advanced is probably the Fairchild Petrel (XAUM-N-2). Powered with a Fairchild J44 turbojet—possibly jettisoned before the missile dives into the sea—the Petrel is built to designs initiated by the National Bureau of Standards and is air-launched from Bell HSL anti-submarine helicopters. According to one report it is intended "only for training."

The heat-seeking Eastman Kodak Dove (XASM-N-4) is thought to be a missile in the same class, in one respect at least—that it embodies an under-water self-homing device.

Bombing-up an R.A.F. English Electric Canberra with 1,000-pounders.

Unguided Bombs. Bombs having no guidance systems, and with conventional explosive, incendiary and chemical fillings, continue to be developed for a variety of purposes and in numerous sizes. British bombs of post-war design include a 5,000-pounder for the English Electric Canberra—for which aircraft a known load is two 1,000 M.C. (medium capacity) bombs, two 1,000 lb Mk 8 bombs, and two 800 lb incendiary clusters. Combinations of greater total weight are presumed to be possible.

Typical general-purpose bombs are of 500, 750, 1,000, 2,000, 4,000, 12,000 and 22,000 lb nominal weight.

A British development for the R.A.F. is a V.T.-fused bomb—a 1,000-pounder for day, night and all-weather tactical employment. The fuse is similar to the radio proximity pattern for anti-aircraft shells, and can be set to act with fair accuracy at any one of three predetermined heights above the ground. At a demonstration in Germany during 1953 V.T. bombs appeared to be exploded at 80ft above ground level.

Troops in slit trenches, soft-skinned vehicles and stores and aircraft on the ground can be effectively dealt with by V.T. bombs, the blast and splinters from which are directed downwards over an area which can be accurately determined according to the pre-set height of the burst. In conjunction with remote ground control, the V.T. system allows extremely effective bombing to be done "blind," and from a high altitude, from an aircraft not even fitted with a bomb-sight.

The post-war years have seen the development of specially streamlined stores for external carriage on high-speed aircraft, and the U.S. Navy has a universal "shape" of very low drag for use on transonic and supersonic machines. Designed by Douglas for the Bureau of Aeronautics, it is known under the designation Aero X-1A External Store and may be in the form of a bomb, a fuel tank or a weapons container. Carrying three 2,000 lb bombs of this design, an unspecified aircraft—presumably the Douglas Skyshark—flies over 50 m.p.h. faster than with three standard 2,000 lb bombs, and under specific conditions range is increased. When two of the new stores are used as 150 U.S. gallon fuel tanks the Douglas F3D Skyknight flies over 24 m.p.h. faster than with two conventional-type tanks of the same capacity.

Low-drag bombs developed by the U.S.A.F. for such aircraft as the North American F-100A Super Sabre are 500-, 1,000- and 2,000-pounders, described as "high-explosive supersonic bombs." These can be carried in conjunction with the Pastushin Aviation Corporation forcible-ejection pylon, which ensures that they clear their carriers without damaging the airframe. An ejector charge separates the bomb at transonic or supersonic speed, regardless of aircraft attitude. Another forcible-ejection system for the F-100A is manufactured by the Bohanan Mfg. Company and utilizes twin pistons, actuated by cartridges and exerting a force of 20,000-30,000 lb, through an 8in stroke directly on to the mounting lugs of the tank or bomb.

Little can be said of modern British bombing equipment, but it is known that the Armaments Division of A. V. Roe and Co., Ltd., have developed a triple bomb-carrier designated A.V.151, weighing about 42 lb and carrying three 1,000 lb bombs, measuring 16.5in to 17.8in in diameter. It is presumed that this fitment has been developed for the Vulcan bomber. (Avros, incidentally, have also been working on a single-cell flare chute for stores up to 6in in diameter and 40in in length.)

A notable advance in American bombing technique was the introduction, on the Martin XB-51 three-jet tactical bomber, of a pre-loaded rotating bomb-door, which, immediately prior to the

A 260 lb fragmentation bomb on a Republic F-84 Thunderjet.

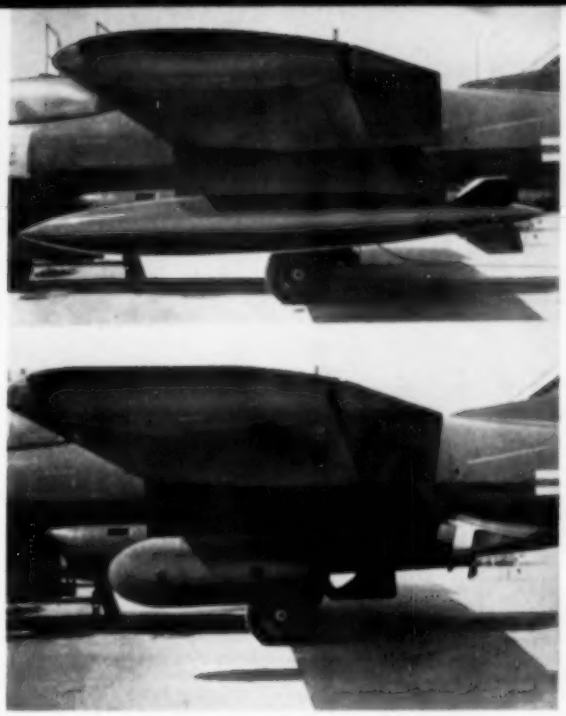
release of the bombs, was swung through 180 deg, leaving no open bay to cause buffeting or other undesirable phenomena. Developed by the Glenn L. Martin Company in conjunction with the Air Research and Development Command of the U.S.A.F., the door is now standard on the Martin B-57 (English Electric Canberra) series of light bombers and night intruders. Through its use, the makers claim, a jet bomber flying at very high speed is just as stable a platform as one flying at 200-250 m.p.h., and it is generally unnecessary to reduce speed for bomb or rocket release, as in the past. (In many instances turbulence has been so strong as to cause bombs to "float" in the open bay.)

The door swings into position quickly and has little effect on speed, trim and stability. In operating position the bombs are externally carried and, except for the time involved in opening and closing the door, there is no recess in the fuselage, and hence no buffeting and no need to reduce speed to ensure a stable platform. Moreover, the "tumbling" which generally occurs, except with the very largest bombs, is remedied.

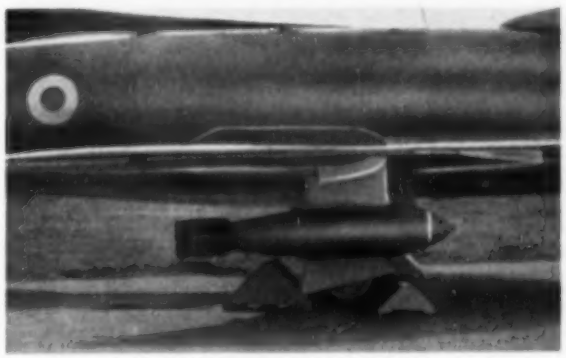
The door is readily removable from the aircraft and, when it has been mounted on wheels, the bombs can be speedily loaded and fused. Having been wheeled once again beneath the aircraft, the complete assembly is hoisted into position by the use of four standard bomb hoists; then, after electrical connections have been made to the release circuits, the door is rotated on its trunnions to the closed position.

Alternatively, the projectile load can be made up of rockets —especially those of the folding-fin type, of which great numbers can be stowed.

On current bombers with more or less conventional bays it is the practice to fit some anti-buffeting arrangement ahead of the forward lip. The second Short Sperrin, for example, has been fitted with a ring of small plates around the front edge of the bay, each plate being hinged about its forward edge in a manner similar



(Above) New-type Douglas "streamlined store" on XF3D-1 Skyknight. Below, on the same aircraft, is an old-pattern 2,000 lb M66 bomb.



Installation of "high-speed" 1,000 lb bomb on Supermarine Swift F.4.

A Boeing mobile bomb-lift handling a 22,000-pounder. A lift of this type is said to be capable of raising a 50,000 lb bomb 12½ft.

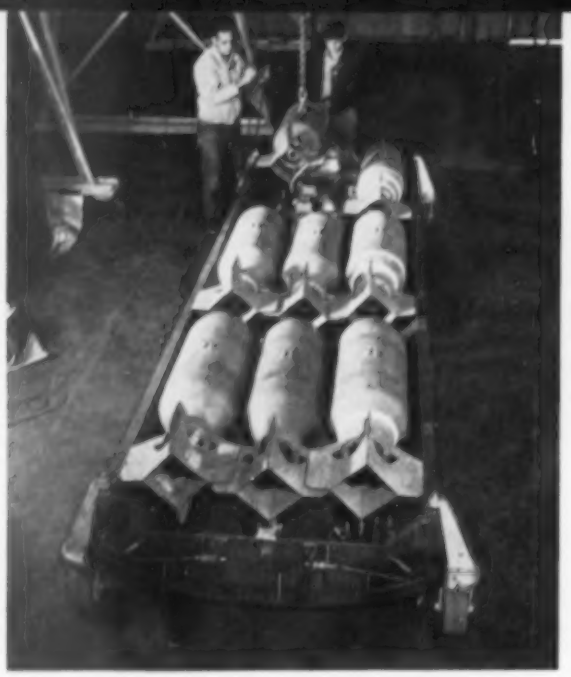
to that commonly employed for the cooling gills of radial piston-engines.

Guided Bombs. The guided bomb, with thermo-nuclear or conventional charge, is a weapon of cardinal importance, though in respect of R.A.F. policy we can only reiterate an utterance of a former C-in-C. Bomber Command (Sir Hugh Lloyd). In December 1952 Sir Hugh averred: "We have got to get away from this free-falling bomb business and put as much effort as we can into the guided bomb as quickly as possible."

Of developments on behalf of the U.S.A.F., on the other hand, it is known that over a considerable period of years the Bell Aircraft Corporation has been developing the Rascal (B-63) from the X-1 supersonic research aircraft, and that weapons of this sort figure prominently in the planning of Strategic Air Command. Rocket-propelled and supersonic (probably Mach 1.5 plus), the Rascal is believed to have a maximum range of about a hundred miles, enabling the bomber to remain well outside the A.A. gun or missile defences of its target. Initial guidance is provided by a pre-set "programming" device, but for mid-course and terminal guidance an operator in the bomber takes over. The release mechanism resembles that developed for the X-1.

Limited production is also known to have been undertaken, on behalf of the U.S. Navy, of the Fairchild Gorgon V (XASM-N-5), described as a "glide-type missile with shear-type wing." Similar in character is the U.S. Navy's Bat (ASM-N-2A), a radar-guided glide-bomb first developed in 1944 but used comparatively recently, it appears, by the U.S. Navy in Arctic-region tests against icebergs.

Shortly after the war promising experiments were made in



Martin rotary bomb door being loaded for fitment to a B-57 (Canberra).

Bat radar-guided glide-bomb as used by the U.S. Navy.

MISSILES AND PROJECTILES . . .

America with the Roc television-guided bomb, wherein the "eye" of the TV was fitted in the nose and radio impulses controlled the trajectory. Another remarkable feature was the use of an annular aerofoil amidships.

Among the pilotless radio-controlled Grumman Hellcat bombers used against targets in Korea were a number fitted with television "eyes," but although success was achieved, it is clear that jamming could, in any future warfare, foil accurate aiming.

Limited use was also made in the Korean war of Tarzon radio-controlled bombs. Weighing some six tons, and 27ft long, these U.S.A.F. weapons are directed by the bomb aimer by means of radio signals picked up by a receiver in the bomb itself. As on the Roc, the aerofoil is of annular form.

"Special Weapons". The so-called "tactical" atomic bomb, as carried externally by the Republic F-84F Thunderstreak, F-84G Thunderjet, and certain fighters and attack aircraft of the U.S. Navy, notably the Douglas AD-4 Skyraider and A4D Skyhawk, is reported to weigh about 1,300 lb. A "special store"—presumed to be a weapon of the same character—has been officially specified for the North American F-100A Super Sabre, and a model inadvertently revealed in the Pentagon has represented this as a cylindrical object.

Specific details of atomic and hydrogen bombs remain entirely secret.

Torpedoes. The last British pattern of air-launched torpedo of which mention is permissible is now many years old. It is the 18in Mk XII, weighing some 1,850 lb and fitted with the "Mat 4" tail, designed to ensure directional stability in the air. A standard U.S. Navy torpedo, as carried by the Douglas Skyraider and Lockheed Neptune, weighs 2,165 lb. The French Navy have experimented with a delta-winged air-launched torpedo which glides towards its target and sheds its wings on contact with the water.

Homing torpedoes are known to be standard items of armament on the Grumman S2F twin-engined anti-submarine aircraft.

Martin rotary bomb door being raised into position on a B-57.

Sea Mines. Understandably, nothing has been disclosed concerning the latest air-laid sea-mines and their fusing systems (magnetic, acoustic or pressure), though the U.S. Navy attaches sufficient importance to such weapons to have ordered a prototype of the Martin XP6M-1 SeaMaster, a very fast four-jet mine-laying flying-boat. The mine bay has Martin rotary doors and is located aft of the pressurized area, immediately forward of the mine-loading compartment, into which the mines are taken through a large hatch in the top decking.

The existence was disclosed after the war of British air-dropped sea mines designated 500 lb Mk 8, 1,000 lb Mk 7, 1,500 lb Mk 4, and 1,850 lb Mk 6; a possible load for the British-built English Electric Canberra bomber is known to be two 2,000 lb parachute mines. The Fairey Firefly will take two mines of 1,000 lb. A 2,000 lb sea-mine is a standard U.S. Navy store, and is carried on the Lockheed Neptune. Similar mines will be laid by the new Douglas A3D, to be operated from the Forrestal-class carriers.

Depth Charges. Standard patterns of British depth charge are of 250 lb and 500 lb nominal weight. The U.S. Navy uses a 325-pounder (twelve of these can be carried internally by the Lockheed Neptune), and a 1,600-pounder, two of the latter being carried by the Grumman AF-2S Guardian.

Napalm. Notwithstanding its successes in Korea, napalm (jellied petrol) has a distinctly limited effect. It produces an intense, but short-lived, flash heat, sufficient to deprive humans of oxygen and to consume cloth and paintwork. A truck not carrying an inflammable cargo would be stopped, but not necessarily destroyed, and it has been found that a man lying in a slit

(*Concluded on p. 129*)

Tarzon radio-controlled bomb of the U.S.A.F., as used on Korean targets. Length is 27ft, weight about six tons.

At the first attempt the Eland has recently passed a 150 hour type test rehearsal at the full 3000 e.h.p. rating.

HIGH AERODYNAMIC EFFICIENCY

The Eland is an aero-engine giving high power at low cost. It is a single-shaft propeller-turbine developing 3,000 e.h.p. at take-off, with a diameter of only 36 inches. This compactness makes for high aerodynamic efficiency. Other notable features include smooth, surge-free acceleration, low specific weight and low fuel consumption. All in all, the Eland is an impressive example of design and manufacture at the service of commercial aviation.

NAPIER Eland

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GUIDED WEAPONS by

'ENGLISH ELECTRIC'

ENGLISH ELECTRIC · MARCONI · NAPIER

G-ANBB, the second production Britannia 100 for B.O.A.C., takes off from Filton on January 18th for its maiden flight. Three Britannias, including the first prototype, are now engaged in intensive pre-service trials.

CIVIL AVIATION

PAKISTANI PROVING

THE pre-inaugural flight of the fastest service between London and Karachi (19 hours' elapsed time) was completed on January 20th with the arrival at London Airport of a Super Constellation of Pakistan International Airlines. Among those aboard the aircraft were the Prime Minister of Pakistan, Mohammed Ali, and the Begum Mohammed Ali. It was manned by a crew of 12, commanded by Captain John Barnes, the Australian operations manager of P.I.A. The other pilots were Captain F. Guthrie (Australian) and First Officer D. David (Pakistani); the crew also included a British navigator, E. R. Plews, and flight engineer, A. E. Newman; an Australian flight engineer, G. Buckman; and a Pakistani radio officer, N. Y. Butt.

P.I.A.'s regular weekly return services between Karachi and London *via* Cairo will begin on February 1st. The Super Constellations will carry 11 first-class passengers and 59 tourist passengers. The airline hopes that the build-up of traffic will soon justify an increase of frequency.

The launching of P.I.A.'s first international service has entailed the conclusion of a number of agreements with other airlines. Thus, technical assistance at London and Cairo will be afforded by B.O.A.C., and K.L.M. will provide facilities for emergency overhauls at Schiphol, Amsterdam. The Dutch airline has also seconded Captain K. Zwarthoed as chief instructor at P.I.A.'s flying school at Karachi where aircrews will be converted to the Super Constellation. Before the establishment of this school many of the Pakistani company's pilots attended courses with K.L.M. at Schiphol.

Airwork, Ltd., will act as P.I.A.'s general sales agents in the United Kingdom. The Pakistani airline has opened a London office in the Airwork town terminal at 249 Brompton Road, London, S.W.1.

D.H. AIRSCREWS FOR C.A.A. VISCOUNTS

AN announcement by de Havilland Propellers, Ltd., states that Central African Airways have specified D.H. airscrews for their new fleet of Viscount 700Ds. Described by the makers as "designed from the outset to cater for the increased powers now being introduced by progressive development of the Rolls-Royce Dart" the new D.H. airscrew has square-tipped solid duralumin blades. Two new features of the airscrew are a lock to secure the blades in the angle at which they are operating in the event of loss of oil pressure to the airscrew controller, and an electric safety stop to prevent inadvertent use of ground-fine-pitch which gives braking effect on touch-down.

INTER-CANARIES SERVICES IMPROVED

SERVICES operated by Iberia Spanish Airlines in the Canary Islands have been expanded recently, following the acquisition of more DC-3s. The inter-island routes are based at Gando Airport, on Grand Canary Island, 20 miles south of the capital, Las Palmas.

Winter season flights to Teneriffe have been increased to five each weekday, with two on Sundays. Flying time is 30 minutes. The Spanish African coast also receives additional services, with a DC-3 flying twice weekly between Las Palmas, Sidi-Ifni, Cabo Juby, Villa Cisneros, and back.

The most notable improvement is the service to Lanzarote Island. Departures are now daily (writes a correspondent), at the somewhat inconvenient time of 0745 hr from Gando Airport (which involves a start by bus from the town terminal in Las Palmas at 0615). Three times a week, the flight for Arrecife, capital of Lanzarote, calls at Los Estancos Airport, Fuertaventura Island. A Spanish Government tourist inn has been built at Arrecife, and attempts being made to popularize the island as a tourist attraction are achieving some success.

Average load factor on the daily service is in the region of 75 per cent, which may be accounted for by the low return fare. Though it is a contentious question, one may reasonably assume that the Las Palmas-Arrecife fare of 360 pesetas return (roughly £3 6s) is among the world's cheapest fares. It involves 276 miles of actual flying, plus 46 miles of bus travel (free under Spanish regulations), at a rate of less than 2½d a mile.

A SYCAMORE IN EIRE

AS briefly reported in *Flight* last week, a Bristol Sycamore helicopter was recently ferried—in the hold of a Bristol Freighter—to Eire. In spite of wintry conditions in Dublin, Mr. Peter Moore (demonstration pilot) and Mr. Alex Langfield (sales representative) displayed the Sycamore's capabilities to a number of interested parties.

The demonstrations were arranged by Aer Rianta, the holding company of Aer Lingus, at Dublin Airport. On January 17th it was inspected by the Army Air Corps at Baldonnel Airfield, and on Tuesday morning to the Commissioners of Irish Lights at Dún Laoire (Kingstown). On the following day the Sycamore was flown from Collinstown to Phoenix Park, where it alighted on the lawn of Aras an Uachtarain (Viceregal Lodge) and was inspected by the President of the Republic, Dr. Sean T. O'Kelly. Later Dr. O'Kelly, with his wife, was given a flight round the city.

At present (writes a Dublin correspondent) the only helicopters on this side of St. George's Channel are those operated by the Royal Navy from bases in Northern Ireland. Aer Rianta, who operate the two airports of Shannon and Dublin, are the most likely purchasers of the Sycamore, though the Army Air Corps and Commissioners of Irish Lights seem very impressed by its potentialities. The demonstration before the latter authority took the form of a passenger pick-up in the harbour, and the Sycamore also delivered newspapers to the Kish Sands lightship.

During its recent series of demonstration flights in Eire (reported above), a Bristol Sycamore landed on the snow-covered lawn of the President's house. Dr. O'Kelly and Mrs. O'Kelly are seen about to take-off in the Sycamore, accompanied by Mr. A. G. L. Langfield (right), Bristol technical sales representative.

CIVIL AVIATION . . .

Now completing pre-delivery tests is the second of T.C.A.'s Viscounts, first aircraft of their type to be powered by the up-rated Dart 506 turboprop. Viscounts of both T.C.A. and Capital Airlines (including the latter's Viscount 700 Ds) are fitted with Rotol airscrews.

QANTAS RE-EQUIPMENT

THE Australian international airline Qantas expects that Super Constellations will comprise its mainline fleet "until about the sixties." This was announced last week by Sir Hudson Fysh, chairman of Qantas, who said that ten of these aircraft would be in service early this year. It was unlikely, he added, that Qantas would re-equip with jet or turboprop airliners before 1960.

Apart from the increased use of Super Constellations one of the main events of the coming year would be the withdrawal of Sandringham flying-boats from the Pacific Island services and their replacement by DC-4s. A first-class-only Connoisseur service, operated with Super Constellations, would shortly be introduced on the Sydney-London route.

Sir Hudson also announced that Qantas carried 118,000 passengers in 1954, over ten per cent more than in the previous year; the airline's freight traffic increased by nearly 23 per cent during the same period, and the total mail load by 27 per cent.

HUNTING-CLAN TO GIBRALTAR

THE opening of a new colonial coach service—between London and Gibraltar—is announced by Hunting-Clan Air Transport. The service, to be inaugurated on February 21st, will be operated with 34-seat Vikings at an initial frequency of one flight per month in each direction. Flights will leave London Airport at 9.10 a.m. and after a technical stop at Biarritz, will arrive at Gibraltar at 5.35 p.m., local time. Return flights, also calling at Biarritz, will leave Gibraltar at 8.15 a.m., local time, arriving at L.A.P. at 4.40 p.m.

By comparison with existing B.E.A. tourist fares for the same route, the new Hunting-Clan service is remarkably cheap: the colonial coach single fare of £16 2s compares with a normal tourist fare of £28 5s, and the return fare is £29 as against £50 17s. Due to its low frequency, however, the independent service is unlikely to divert traffic from the Corporation's more frequent flights by Pionairs and Viscounts.

BREVITIES

THOUGH Qantas have operated through Manila for several years, a clause in the bilateral agreement between the Australian and Philippine's Governments prevented the Australian airline from carrying local traffic between Manila and Tokyo. Following recent negotiations between the two governments, Qantas have now been granted full traffic rights on this sector.

* * *

Formerly traffic superintendent at Dublin Airport, Mr. S. H. Mayne will shortly replace Mr. J. P. G. Fitzgerald as district traffic superintendent for Aer Lingus in London. Mr. Fitzgerald is going to a new appointment as traffic superintendent at Cork, where the airline is opening new offices.

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Congonhas Airport, Sao Paulo, last year maintained its reputation as one of the busiest airports in South America. The number of transport aircraft movements during the first nine months of the year was 59,000, and the number of passengers handled was 775,000.

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Aer Lingus report the carriage of 336,000 passengers last year—an increase of 13 per cent over the 1953 total. The company's total cargo uplift (6,200 tons) showed a 22 per cent increase. Due to the introduction of Viscounts, the additional Aer Lingus traffic was carried on fewer flights and involved less flying time than in the previous year.

* * *

The A.R.B. announces the following *Notices to Licensed Aircraft Engineers and to Owners of Civil Aircraft:* Contents list, Issue 17; No. 2, Issue 10, dealing with the renewal of aircraft maintenance engineer's licences; No. 4, Issue 16, listing propellers approved for use on civil aircraft.

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Cloud-warning radar of American manufacture (make unspecified) has been ordered by K.L.M. for installation in the four L-1049G Super Constellations due for delivery to the airline in February 1956.

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According to a report from Belgrade, negotiations are now being conducted by the Yugoslav Government with a view to obtaining new international traffic rights for the state airline J.A.T. It is proposed to open services to London, Athens, Cairo, Istanbul and Beirut.

* * *

The Lockheed Aircraft Corporation have announced the appointment of Mr. C. F. C. Meuser, until last year an executive of K.L.M., as their director of sales for Europe, Africa and the Middle East. Mr. Meuser will be assisted by the newly appointed director of technical sales, Mr. E. S. Fife; both will make their headquarters at Geneva.

* * *

A preliminary announcement on the summer schedules to be introduced this year by Air France states that the airline will operate ten Viscount services daily between London and Paris, including one first-class Epicurean flight at lunchtime and off-peak services at special low rates each morning and evening. There will be a nightly Viscount tourist flight from London to Nice.

This was the scene at London Airport on the night January 11/12th, as an Airwork Viking was prepared for the inauguration of the company's fortnightly freight service to Frankfurt. Bales of furs and clothing were among the outward loads; items carried on the return flight included perfume and artificial jewellery.

PROMOTING THE ELAND

IN addition to their recent announcements of power figures and other data, the Napier company last week discussed plans for flight-testing, producing, demonstrating, and selling their promising Eland turboprop both at home and overseas. Some comparative details of the engine itself are to be found in an article on pages 100 and 101, and an illustrated description appeared in *Flight* of July 23rd, 1954.

Arrangements made for the Eland's future have been finalized following a visit by Mr. H. Sammons (managing director) and Mr. R. M. Hilary (commercial manager) to which reference was made last week. The rapid and satisfactory progress made with the engine to date is attributed to a large extent to the development of each main unit separately at the company's new test station at Liverpool. Thus, for example, the reduction gear has been running at and above maximum load from the beginning, rather than having to wait for the whole unit to be developed up to its designed output figure of 3,000-3,250 e.h.p. for the first stage and 4,000-4,200 e.h.p. later.

Napiers believe that a manufacturer of a new civil engine can no longer depend upon military contracts to develop and sell his products, nor, they hold, are flying hours in non-representative test-bed machines sufficient to ensure adoption. While welcoming the help received from the M.o.S. the company therefore went ahead on their own and bought a Convair 340 which is now undergoing conversion to Eland power at Luton. In addition, the loan of an Ambassador prototype will provide another aircraft which can, like the 340, be put into trial airline service with Eland power. Both these machines are suitable for conversion and it is hoped that, in the event of the first Eland 340 making a favourable impression in the United States, many or all of over 300 Convair 340s, and perhaps some Martin 404s as well, will be re-engined with Napier turboprops by their operators.

B.E.A. are the only operators of Elizabethans and they too will be watching with more than academic interest the conversion and demonstrations—all at Napiers' expense—of the Eland-powered prototype G-ALFR.

The first aim, however, must be to convert and test these two aircraft as quickly as possible, then to obtain full C.s of A. for operation at home and in Europe and the United States as appropriate. The timing foreseen is: Convair 340 ready to fly with 3,000 s.h.p. Elands in July; full C. of A. and American C.A.A. approval by, perhaps, March of 1956; trial operation with an American airline during the summer of 1956. Orders for production Elands (3,000/3,250 e.h.p.) could start to be met in quantity by January of next year. Flight engines for prototypes can be supplied this year.

The Convair 340 conversion is relatively simple and the benefit to performance (some 4 m.p.h. cruising speed) which might be realized if a slimmer nacelle were to be fitted, is not considered sufficient to justify the extensive additional work. The conversion as foreseen will therefore be from the existing piston-engine bulkhead forward.

A great deal of the existing wiring, pipelines and instruments are being retained in the Convair and, in order the better to demonstrate in the United States, American-type auxiliaries will be retained so far as is possible. Consideration is even being given to the fitting of American airscrews when the machine has crossed the Atlantic. The cost in America is expected to be no more than £100,000 dollar equivalent.

The Eland has no competitor in America; and should a demand develop for a turboprop in this power class, as seems probable, it might be built there under licence. In fact, provisional plans are believed to exist for such a step. Should orders be obtained from the U.S. Services, a home production-line would certainly be demanded.

As a member-company of the English Electric Group, Napiers have the advantage of the help and advice of associated firms in many countries abroad. In addition, they have behind them at home almost unparalleled resources for research, production, sales and servicing.

In passing, we may wonder whether their connections with the English Electric company might not lead Napiers to convert a Canberra to Eland power for high-altitude and high-speed development. This aircraft would seem to be suitable for such work.

V.1s AND V.2s ON TV

ENTITLED *Facing New Weapons*, Episode 11 of the B.B.C. television film *War in the Air* opened with the briefing of bomber crews for the heavy raid of August 17th, 1943, on Peenemunde, the big German experimental weapon station on the Baltic coast.

A total of 597 Lancasters, Stirlings and Halifaxes took part in this raid, which was considered one of the most important of the war and which saw the use of the master-bomber technique for the first time. Under this system a master bomber patrolled the target while the attack was on, and instructed the oncoming bombers where to drop their bombs; sequences were shown depicting the method in action.

Forty aircraft failed to return from this raid, the effects of which it is difficult to assess accurately even today. Enemy losses, according to German figures released after the war, were 735 dead, including 178 of the 4,000 skilled workers living on the site—of which only two, however, held positions of importance. Material damage to the works proved less than was believed at first sight. For example, the big assembly hall was hit by nine 1,000 lb bombs and many phosphorus and other incendiaries, but damage to the actual machines and material was not serious. The test fields, wind tunnel and measurement house were not hit at all. By repairing only essential buildings, not re-roofing some workshops and by careful camouflage, the effect of complete destruction was maintained for nine months, during which there were no more raids. It is thought that the raid interrupted work on the V.1 and the Me163 rocket fighter, but not the V.2.

Developments leading up to the establishment of Peenemunde were shown, including brief shots of an early Opel rocket-propelled car, a "*Repulsor*" of the German Society for Space Travel, the Ernest Hatry rocket-propelled glider sponsored by Opel in 1929, and a He111 assisted at take-off by two Walter rocket boosters slung under its wings.

The launching of the V.1 flying bombs was then covered and it was stated that "stripped-down" Tempests, Typhoons and Spitfires had barely sufficient speed to intercept them. So far as the Tempest was concerned this was untrue; it could overtake V.1s comfortably—though probably not when carrying bombs, as was shown in one shot in the film!

Whittle's great contribution to jet propulsion was then covered incredibly briefly by a glimpse of an early engine under test, some interesting shots of the Gloster E.28/39 in flight, early Meteors, and shots of some of these in action against flying bombs—in which a few flashes of the much later Mark 8s were seen! The film gave the impression that most of the flying bombs were destroyed by Meteors when, in fact, it was the Tempests that achieved by far the greatest number of "kills."

The steps taken to combat the V.1 were then covered. These included moving most of London's A.A. defences to the coast, strengthening the balloon barrage South of the Capital, and, above all, constant air attacks against the launching sites under the code-name Operation Crossbow. The combined effectiveness of these measures may be judged from the fact that by the end of August about 100 bombs, instead of the planned 6,000, were launched daily, and of these only four got through to London.

The film then left the V-weapons and returned to the land fighting along the Normandy coast. The heavy tactical "carpet-bombing" raid by Bomber Command near Caen was depicted, but no mention that the result was disappointing was made—the dust cloud produced drifted over the Allied troops, who were then bombed by later waves of bombers, and the ground was so badly churned up by the heavy bombs used that troop and tank movements were hindered rather than helped.

Some idea of the terrible carnage caused by rocket-firing Typhoons during the Caen-Falaise battle was then given. Camera-gun shots showed clearly the accuracy of the rockets, which were considered by the German troops the most fearsome weapon in the Allied arsenal. The Typhoons destroyed over half of the 400 tanks the Germans had in action. Many direct hits on ground vehicles were easily seen.

A switch back to the V-weapon front then covered the introduction of the second reprisal weapon, the V.2. Several launchings of test rockets were shown, including one spectacular misfire of one of the rockets becoming unstable at take-off, toppling over and then exploding. This was inferred to have been an operational mishap; in fact, it was a now classical misfire that occurred in one of the test stands at Peenemunde.

The film ended with the big airborne attack on the Dutch waterways in an attempt to out-flank the Siegfried line and end the war "by Christmas." Shots shown included Stirlings and Albemarles tugging off Horsa gliders, and Dakotas in impeccable formation while on their way to the dropping zone. Ground shots showed German anti-aircraft guns firing at the Allied transports and, also, several wrecked and burning gliders. Our heaviest initial losses were caused by gliders crashing into each other when landing.

M. F. A.

SILENCING A WS-55

The Vokes silencer is shown clearly in this take-off view. The ground observer (right) is operating a Dawe sound-meter.

"Flight" photographs

AN effective method of muffling the sound of piston-engined helicopters was demonstrated last Monday at the South Bank site in London. The demonstration took the form of several flights by a Westland S-55 Whirlwind fitted with an external silencer designed by Vokes, Ltd., and developed by Westland under M.o.S. contract.

The silencer was produced "hurriedly" in order to determine the value of this means of quietening helicopters; design and installation took only ten days to complete. Nevertheless, observers on the South Bank agreed that the noise level was greatly reduced. With the S-55 cruising overhead at only 500ft, the purr of its Pratt and Whitney Wasp (600 h.p.) seemed scarcely audible above the surrounding traffic sounds—an impression confirmed by measurements taken on the spot with a Dawe sound-level meter, which recorded the noise-level of a steam train passing over nearby Hungerford Bridge as 84 db, compared with 82-83 db from the helicopter.

When the WS-55 touched down some 50 yd away, the meter showed 104 db, which is comparable with the level of interior noise experienced in an underground train. In offices (including those of *Flight*) immediately adjacent to the line of flight and well above the street the noise was practically inaudible.

Detailed measurements of the degree of sound-reduction effected have been made by the National Physical Laboratory, and though full figures are not yet available, it has been stated that the average reduction is of the order of 10 db.

Resembling a large exhaust system of car or motor-cycle type, the pipe and silencer lead aft from the normal stub terminating just beyond the port-side rear window. Exhaust gases flow straight through the system, without baffles and a minimum diameter of 5½in; thus, there is virtually no back-pressure (the figure is about 1½in of water) to cause loss of power.

Mr. G. H. Vokes, assistant chief designer to the firm which produced the silencer, explained that the expanded portion of the pipe incorporates two Helmholtz resonators, or acoustic chambers, tuned to a frequency of 169 c.p.s. (which corresponds to the mean firing frequency of the engine at the most noisy conditions); two smaller chambers to suppress the sound at medium frequencies; and lagging of the outlet pipe to deal with high frequencies. The system is not applicable to turbines.

The weight of the Vokes silencer is quoted as approximately 60 lb, and of the provisional installation as a whole about 85 lb. It is understood that a silencing system for an S-55 tried out in America early last year also weighed approximately 85 lb. A careful examination is now to be made by all concerned—manufacturers, operators and Ministries of Supply and Civil Aviation—to discover the best ways of applying the knowledge now being gained and of designing a really practical silencing system. For example, it has already been suggested that twin silencers, fitted in conjunction with the floats and involving only short delivery-pipes, might offer advantages.

If the system is to be adopted on the two WS-55s recently purchased by B.E.A. for their proposed shuttle service between the South Bank and London Airport it will be necessary to reduce the weight to the absolute minimum. The weight of amphibious gear already to be carried by these helicopters will limit their seating capacity to five passengers (instead of a possible eight), and the Corporation will be understandably anxious to avoid further loss of payload. At the same time, one of the purposes of the early services is to establish public confidence in the helicopter, and a measure of noise reduction should help to dispel the antagonism already evoked in some quarters by the comparatively modest number of flights made from the South Bank last summer.

The audience at the South Bank demonstration included Sir Edward Boyle and Mr. John Profumo, Joint Parliamentary Secretaries to the M.o.S. and the M.T.C.A. respectively. Shown here are (left to right) Sir Edward Boyle, Mr. G. H. Vokes, Mr. Profumo and Mr. C. G. Vokes.

SWEDEN'S TEN-YEAR PLAN

THE defences of Sweden are to be modernized under a ten-year plan, according to an announcement by the Supreme Command, and guided missiles will play a key rôle. They will be used by all three Services and some have already been tested by the Army, which has lately reduced its number of field battalions by 12 per cent. Missiles, too, will form the main armament of the destroyers *Smaaland* and *Halland*, now under construction at Gothenburg, and will, of course, be carried by the Saab Lansen attack aircraft. In the anti-aircraft rôle—operated by the Air Force—missiles will also figure prominently, and one type now under development should have a range of up to 150 miles.

PLANNING IN HINDUSTAN

THE Hindustan Aircraft Company at Bangalore, which is owned by the Indian Government, is planning to build aircraft not only for all the requirements of India, but for those of neighbouring countries, including Ceylon. This has been announced in Colombo by the sales executive of the company, Mr. H. S. Kaviratne. Designs are in existence for a basic jet trainer—the HJT-16—which is said to resemble the Morane Saulnier Fleuret, and for an advanced jet fighter known as the HJT-17. A "turbo-propelled" (presumably turboprop) transport, designated HP-18 and intended as a Dakota replacement, is also foreseen.

Piston-engined trainers of the HT-2 type, entirely designed and manufactured by the Hindustan Aircraft Factory, took part in the recent display at Ratmalana Airport, Colombo.

AIR LEAGUE'S NEW CHAIRMAN

IT was announced this week that Air Chief Marshal Sir George Pirie, K.C.B., K.B.E., M.C., D.F.C., LL.D., has been elected chairman of the council of the Air League of the British Empire. He succeeds Air Chief Marshal Sir Guy Garrod, G.B.E., K.C.B., M.C., D.F.C., LL.D., F.R.Ae.S., who remains a member of the council. Sir George Pirie retired from the Service in 1951. His last appointment was as Head of the Air Force Staff, British Joint Services Mission, Washington. He had also been C-in-C. Far East Air Forces and Air Member for Supply and Organization.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

C.A.S. Visiting Norway

AT the invitation of General O. Lambrechts, Commander-in-Chief, Royal Norwegian Air Force, Marshal of the Royal Air Force Sir William Dickson, Chief of the Air Staff, is this week paying an official visit to the Norwegian Air Force. He is accompanied by A. Cdre. K. B. B. Cross, Director of Operations (I), in charge of Air Defence matters in the Air Ministry.

The invitation is a mark of the close ties which exist between the Royal Norwegian Air Force and the Royal Air Force. During his stay in Norway, Sir William Dickson is expecting to have discussions with the Norwegian Minister of Defence and the Joint Chiefs of Staff, in addition to completing a full programme of visits to Royal Norwegian Air Force units. He will also have the honour of being received in audience by His Majesty King Haakon.

F.A.A. Reorganization

TO fall in line with the present system of commissioning aircraft carriers in such a manner as to limit the time spent overseas by ships' companies, the front-line squadrons of the Fleet Air Arm are to be reorganized.

Under the new arrangement, which takes effect from March, three squadrons will be disbanded every 18 months. During each active period there will be seven months' working-up at a shore base and a further eight months embarked in a carrier. These squadron cycles will begin on March 14th with the formation of two squadrons of Sea Hawks and one of Gannets.

Working-up the new squadrons will be the responsibility of Rear-Admiral Guy Willoughby, Flag Officer Flying Training.

The carriers in which these squadrons will operate will be *Ark Royal, Eagle, Hermes, Albion* and *Centaur. Bulwark*, the fourth Hermes Class ship, is to become the trials and training carrier.

Sea Power and the Air

ON the occasion of his installation as Rector of Aberdeen University on January 21st, Admiral of the Fleet Sir Rhoderick McGrigor had a good deal to say regarding the place air power now takes in relation to command of the sea.

He first delved into history and traced Britain's rise to greatness and wealth by command of the seas. Coming then to more recent times and referring to the maritime side of the last two wars Sir Rhoderick said: "In each of these wars the issue has depended on sea power and our ability to move our merchant ships and troop ships in the face of the threat from enemy surface ships, submarines and aircraft. The victory at Alamein was made possible by sea power, by the battle fought against U-boats in the Atlantic, and by the determination and leadership of Andrew Cunningham in the Mediterranean in the face of the numerically superior Italian fleet and the constant menace of the enemy's aircraft.

"For the other side of the picture, we saw what happened in the Pacific when sea power was lost to the Japanese and how the Americans fought back and regained it with the new weapon of naval air power and drove the Japanese back to final defeat."

Of the naval/air problem of today he had this to say: "There are the ships of the Royal Navy and the aircraft which work with them. Today, there is much uninformed talk about the rôle and future of the Navy in this nuclear age and amateurs in every walk of life have no hesitation in expounding their views on this subject.

"These," said Sir Rhoderick, "are the facts. As long as we need merchant ships to supply us and to carry and support our forces overseas, they will need protection against whatever danger may threaten them. That protection is the task of the Royal Navy; that is the reason why we have a Navy. Where so many have gone wrong is that they have not realised that air power at sea is not something which replaces the Navy, but it is the instrument by which the Navy today so largely exercises its sea power. Whether the aircraft are shore-based or carrier-borne must be a matter of convenience, of geography, and of availability of shore bases.

"The aircraft today is both the striking power of the Fleet, largely replacing the 15in gun of the battleship, and the eyes of the Fleet, largely replacing the cruiser in this respect. It plays its vital part in a number of other rôles such as killing the U-boat, defence against air attack, and minelaying. In co-operation with the surface ship and the submarine, it is an essential part of sea power.

"Since the war we have embarked on a new era of nuclear power. Today it is more than ever necessary for all the fighting Services to walk hand in hand with the scientist to ensure that the lessons they draw from the past are still valid and that they are not preparing to fight the last war over again . . .

". . . Today Russia has a great and growing fleet of surface ships, U-boats, and shore-based naval aircraft, presenting a naval threat greater than we have experienced before. As for us, we still live on an island and it is still vital to us that supplies should continue to reach us from overseas so that our people may eat, our armies may fight, and our aircraft may fly . . .

". . . Air power at sea is all important and its place is as the instrument of the Navy in the application of sea power."

The Bahrein Accident

ON January 17th, whilst on a flight from Bahrein to Shaibah in the Persian Gulf, a distance of 340 miles, an Anson carrying five officers and a sergeant met with an accident. The last contact with the aircraft was at 0838 G.M.T. when it was 55 minutes outward bound.

Those lost with the aircraft were: G/C. H. J. Irens (pilot), Sgt. Radley (signaller), G/C. A. M. Aberdein, W/C. M. Dean, S/L. R. H. Stevenson and F/L. Cranley.

A search was instituted by a Hastings from Shaibah, a Valetta from Bahrein, a U.S.A.F. Dakota from Dharan, seven Venoms from Habbaniya and Austers from Kuwait, surface craft also assisting. Later, parts of the aircraft and the bodies of G/C. Irens and W/C. Dean were found by H.M.S. *Owen*. The two officers were buried at sea.

Rhodesian Air Attaché

IN succession to W/C. K. D. Taute, D.F.C., Royal Rhodesian Air Force, W/C. H. Hawkins, A.F.C., has been appointed Air Attaché at Rhodesia House, London. W/C. Hawkins, who has just spent a year at the R.A.F. Staff College, Bracknell, was born at Toowoomba, Australia. He has flown in most areas of the world, including the Antipodes, the Pacific, North America, Europe and the Middle East. W/C. Taute was due to leave for Southern Africa on January 20th.

Malaya Airfields to be Rebuilt

IN order that they may be suitable for the operation of modern bombers and fighters, the airfields at Kuanan, Alor Star and Gong Kedah in the Malay Peninsula are to be rebuilt and extended. The cost is expected to be in the region of £1,500,000 and the work is due to be completed by next autumn.

Lloyds Trophy

FOR the second year in succession No. 2605 (County of Warwick) L. A. A. Squadron, commanded by S/L. C. B. Barrett, has won the Lloyds Trophy. No. 2602 (City of Glasgow) Squadron came second and No. 2608 (North Riding) Squadron third.

Engineering Appointments

AFTER nearly two years' service as Director of Maintenance and Supply to the Royal Pakistan Air Force, A. Cdre. W. R. Worstall, O.B.E., A.F.R.Ae.S., is to become Director of Air Engineering at the Air Ministry. His post in Pakistan is being filled by G/C. W. D. J. Michie, who will assume the acting rank of air commodore.

R.N. Appointments

TWO recent Naval appointments are those of Capt. W. A. F. Hawkins, D.S.O., O.B.E., D.S.C., to H.M.S. *Albion* in command, and Capt. A. E. Turner as Superintendent R.N. Aircraft Yard, Fleetlands.

A Vampire T.11 in the final stages of a mock attack on a flag air-to-air firing target towed by a Meteor 8. The two-seater is generally used to demonstrate the sequence of the quarter attack, from which the T.11 in the photograph is just about to break away. The target is towed at 180 kt, usually at low altitude over special ranges at sea.

The Future of the R.Aux.A.F.

Dangers Foreseen in the New Government Proposals

THIS article emphasizes the dangerous situation in which the Royal Auxiliary Air Force is likely to find itself if the new Government proposals for its future are adopted. The author, who is well placed to form a judgment, fears that the force will be so weakened as to be in danger of collapse. "Flight" shares his uneasiness; we feel that it would be better to keep a few full strength squadrons in operational existence than to maintain a skeleton force certain to lose the enthusiasm that has been so characteristic of the R.Aux.A.F.

PROPOSALS for the re-organization of the Royal Auxiliary Air Force in the light of today's concept of a nuclear war and the advent of swept-wing fighters will shortly, it is hoped, be debated in both Houses of Parliament. It is pertinent, therefore, to ask ourselves whether this branch of the Service has outrun its usefulness, how and why it operates and, above all, whether or not it would be capable of playing an effective part in any future war. In addition, the blunt but vague statement made recently by the Minister of Defence (and repeated by the Secretary of State for Air) on the future composition of these squadrons is worthy of closer inspection. Detailed plans appear to be far from finalized, but the scheme has received some amplification so far as the Service is concerned and no one in the squadrons has been left in doubt that drastic cuts and alterations are intended for the future. It is possible, and it is indeed to be hoped, that certain revisions may be made before the plan is put into action.

Nearly thirty years ago Marshal of the Royal Air Force Lord Trenchard brought the first four Auxiliary squadrons into existence. Based on a scheme similar to that of the Territorial Army, the intention was to create an active R.A.F. reserve composed of volunteer pilots, navigators and ground crews formed into squadrons and trained to take their place as integrated front-line units on the outbreak of a war. As in the case of the Territorial Army, here would be not only a useful, comparatively cheap and well-trained reserve but one which would permit a reduction in the size, and therefore the cost, of the regular peace-time Air Force. Today no country is more vulnerable to attack from the air than the United Kingdom; never, therefore, has there been a greater need for a strong and efficient air force reserve equipped and conversant with modern aircraft.

By the outbreak of the last war the Auxiliary Air Force had increased to twenty squadrons, and it is unnecessary here to relate the part they played up to and during the Battle of Britain—ably supported, as was the R.A.F. as a whole, by pilots from the Royal Air Force Volunteer Reserve. Had there been no Auxiliary squadrons, no R.A.F.V.R. and no breathing space in which to bring pilots of the latter up to operational standards, the R.A.F. might well have been overcome during the air battles of 1940.

Today the R.A.F.V.R., with the exception of the University squadrons, has been disbanded for reasons of economy, and the fate of the Royal Auxiliary Air Force hangs in the balance.

The reasons put forward for re-organizing the R.Aux.A.F. are various—and, in the writer's view, are an attempt to conceal the truth. Financial stringency is the real root of the evil and it is clear that the R.A.F. requires a larger share of the Defence Estimates if it is to maintain an efficient force of highly complicated and expensive aircraft.

The R.A.F.V.R. was disbanded on grounds of economy, and it is this that underlies the proposed changes to the R.Aux.A.F. Suggestions that "week-end" pilots would be unable to manage swept-wing fighters, either because of insufficient flying practice or because their average age is too high, are red herrings bearing little relation to fact. At one stage in the history of the Auxiliary Air Force it was considered that D.H.9A.s might prove too advanced for Auxiliary pilots; surely the transition from Spitfires to jet aircraft was greater than that from Meteor to swept-wing fighter is ever likely to be? No ruling has been put forward by the Institute of Aviation Medicine on the question of an age limit, and the Americans found in Korea that the older and experienced pilots proved more efficient than their younger counterparts. In any event, the ages of pilots in the Auxiliary squadrons can be limited within reason—as, presumably, will have to be done in the case of squadron leaders and wing commanders in the R.A.F.

The strength of the squadrons of the R.Aux.A.F. lies in their spirit, their prolonged and frequent flying as a team, the fact that the pilots are hand-picked, the keen inter-unit rivalry, and the wish to be a credit to the respective counties or cities to which they belong. These are the reasons why the pilots spend their week-ends flying, obtain instrument ratings, carry out night reinforcements, put up reasonable air-firing scores and undertake to the best of their ability, whatever is asked of them.

By cutting the size of the squadrons and reducing the number of aircraft; by sending the pilots, in some cases scores of miles from their bases, to fly the swept-wing fighter of the Regular squadrons and by thus damping the spirit and enthusiasm of the ground crews who form an integral part of the squadrons; by such measures the Royal Auxiliary Air Force will be grievously impaired.

Rather than reduce the R.Aux.A.F. as a whole to a mere skeleton, it would be better to disband temporarily those squadrons which cannot reach the necessary standard of efficiency—however unpopular such a move would be. It is not, however, within the scope of this article to put forward solutions to the problem, although no doubt many exist which would provide a better answer than the present proposals. The main object is to stress the importance of keeping the R.Aux.A.F. alive and efficient, and any means to this end must be based on today's formation of individual squadrons.

Should the present proposals have the calamitous effect on the R.Aux.A.F. that its members fear, then the R.A.F. and this country might well have cause to regret these decisions.

"For want of a nail the shoe was lost . . ."

GOODYEAR MOVEMENT

AS recorded in *Flight* of November 12th, 1954, Mr. Walter A. Hazlett has retired from the managing directorship of the Goodyear Tyre and Rubber Co. (Great Britain), Ltd., in order to return—after 17½ years in England—to his American homeland, where he will become vice-president of the parent company. He sailed for home on January 10th; shortly before, at a farewell dinner, he had been presented with an engraved scroll and engraved silver salver; the presentation was made by Mr. A. S. Bishop, who succeeds him as managing director.

Mr. Walter A. Hazlett

Other news from Goodyear is that Mr. T. C. Wallace, manager of the aviation products department of the American company, has been appointed manager of the aviation products department in this country. He joined Goodyear soon after the last war, in which he had seen service with both the British and the United States Air Forces.

Mr. T. B. O'Reilly, previously aviation manager at Wolverhampton, is going to the United States for duty with the export aviation products department of the parent company.

FORTHCOMING EVENTS

Feb. 1. Institute of Transport: Informal luncheon.
Feb. 2. Royal United Service Institution: "The Greenland Expedition," by Cdr. (L) C. J. W. Simpson, D.S.C., R.N.
Feb. 2. Women's Engineering Society: "The Work of the British Standards Institution," by L. G. Watkins.
Feb. 5. British Interplanetary Society: "The Development of the Swarler Rocket Motor," by D. Harden, B.A., Grad.I.Mech.E.
Feb. 5. British Interplanetary Society (Midlands branch): "The Atmosphere and Space-ship Design," by A. H. Wickens, B.Sc., D.I.C., Grad.R.Ae.S.
Feb. 8. R.Ae.S. Section lecture: "Some Trends in the Development of Aircraft Electrical and Starting Systems," by R. H. Woodall, F.R.Ae.S.
Feb. 10. R.Ae.S. Main lecture: "Problems and Prospects of Rocket Propulsion for Aircraft," by Prof. A. D. Baxter, M.Eng., F.R.Ae.S. (at I.O.W. Branch).
Feb. 11. Helicopter Association: "Development Experiences with the Bristol Type 173," by R. Hafner, F.R.Ae.S.
Feb. 14. Institute of Transport: Brancker Memorial Lecture: "Influence on Civil Aviation of Some Current Researches," by Sir Arnold Hall, F.R.S., M.A., F.R.Ae.S.
Feb. 15. R.Ae.S. Graduates and Students: Discussion: "Is Post-graduate Study Abroad Worthwhile?" (chairman, Sir Arnold Hall).

R.Ae.S. Branch Fixtures (to Feb. 10):—

Jan. 31, *Halton*, Junior Members' night.
Feb. 2, *Chester*, "Global Winds and Weather," by C. S. Durst; *Brough*, "Accidents," by A. Cdre. Sir Vernon Brown; *Luton*, "Controls and Stability," by J. Wimpenny; *Southampton*, "The Lightweight Jet Engine," by Dr. S. G. Hooker. Feb. 3, *Cheltenham* (area lecture: Coventry, Birmingham, Gloucester and Cheltenham branches), "Comparisons of Some Aircraft Propulsion Systems," by Prof. A. D. Baxter. Feb. 7, *Belfast*, "Rocket Motors," by D. G. Kennedy; Feb. 8, *Boscombe Down*, film evening. Feb. 10, *I.O.W.*, main lecture (see above).

MISSILES AND PROJECTILES

(*Continued from page* 122)

trench, covered with a blanket, can survive uninjured the flash heat of a napalm burst. A tank, if battened down and properly managed, would suffer only superficial damage. However, napalm remains distinctly effective against soft-skinned targets. To ensure the proper flame spread the dropping aircraft must make a fairly fast run as low as possible, thus achieving surprise and providing a difficult target for A.A. defences. Release at too high a speed causes such a spread of flame as to reduce effectiveness.

The American-type napalm tanks commonly used by the Republic Thunderjet must be released from a greater height than is possible with made-up British tanks (stocks are not normally held by the R.A.F.) because of the particular fusing arrangements. A possible load of the North American F-100 is two "750 lb napalm bombs" and small tanks of 40 U.S. gal capacity have been developed for the Fletcher Defender light ground-attack aircraft.

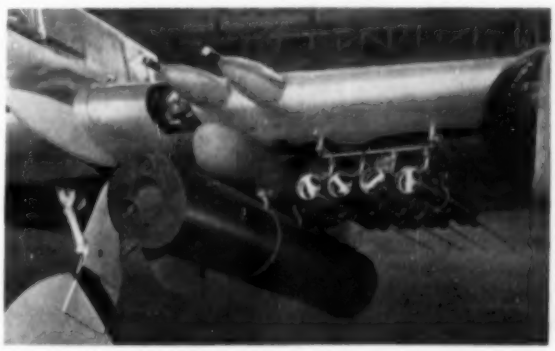
Napalm tanks used by the R.A.F. in a 1954 demonstration were auxiliary fuel tanks filled with inflammable material, differing somewhat from the American napalm. The limiting speed for height and release were quoted as 350 kt and 50ft, and detonation was achieved by means of a phosphorus grenade, with an all-ways fuse placed into the tank itself.

Anti-personnel Darts. Anti-personnel (fragmentation) bombs and clusters continue in service, but a post-war U.S.A.F. development—apparently having a very restricted application—is an anti-personnel missile developed at the Armament Centre, Eglin Air Force Base. Recalling the *flechettes* of the First World War and known as Lazy Dog, this is a steel dart, a few inches long and resembling a tiny bomb. It is intended for use against troop concentrations from low-flying aircraft.

H. F. K.

Republic F-84F Thunderstreak releasing napalm after a previous attack.

U.S. Marines leave their fox-holes during tactical atom-bomb tests in the Nevada Desert. (Above, left) HVARs and napalm tanks on a tip-tanked Martin B-57 night intruder.



(Above) 1,000-lb mine and four American-type sonobuoys on a Fairey Firefly. (Below) Filling 110-U.S.-gallon napalm tanks on an F.84E.

CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns; the names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

Security ad Absurdum

THE action of the Ministry of Supply in banning three lectures to be given at meetings of the British Interplanetary Society brings to a head a situation which has been viewed with concern over the past two years. No one is likely to challenge the need for genuine security measures, but when "security" prevents the free interchange of harmless technical information, the situation calls for an enquiry at the highest level.

What is the reason for the Ministry's action? Ostensibly, it is to prevent people engaged on defence projects from giving information in technical journals which may be useful to a potential enemy. Yet B.I.S. papers have been banned which are nothing more than extrapolations of techniques that have already been freely discussed!

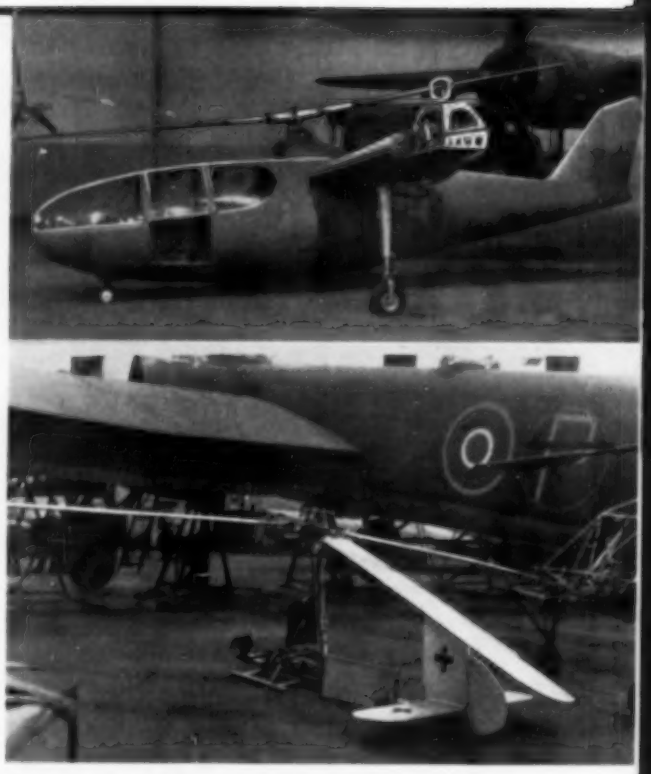
In any case, all scientists and engineers engaged in the Government defence programme are required to submit papers for Ministry "vetting" before publication, when any doubtful security item can be deleted. In exceptional circumstances, the Ministry can insist that there is no public discussion at the meeting after a paper has been read. Yet the present case goes beyond censorship: authors are faced with the actual suppresion of their lectures. Thus, the Ministry of Supply is placing a strangle-hold on the free expression of technical information, not only between the scientist and the public but between the defence scientist and the scientist acting outside the military field. In fact, so ludicrous is the present position that the Society is reduced to the point where foreign scientists and engineers are being invited to give the *same lectures* that our own people are prevented from giving.

Quite apart from the principle involved, this can be nothing but detrimental to scientific advancement in this country.

Whitton, Middlesex. KENNETH W. GATLAND.

In Cranfield's Museum

I ENCLOSE, for your interest, two photographs [reproduced above—Ed.] taken recently at the College of Aeronautics, where the two machines shown are stored together with the following: 2 Sikorsky R-4s; Westland Wyvern (early production Mk 1 with low fin); Avro Lincoln prototype; Bristol Beaufighter nose section; Saro SR A.1; Consolidated Liberator transport (cost £50 in flying condition); Me 163; Hawker Tempest (prototype LA607); pieces of Spitfire, etc., etc.



The Cranfield aircraft referred to by Mr. John Gaylard.

One of the photographs shows (incomplete) the Firth FH 1, civil registration G-ALXP, a prototype helicopter built by Airtech, using the fuselage of the second prototype Planet Satellite. It is based upon U.S.A. patents held by Langdraf. In the background are the rotors of one of two Sikorsky R-4s and the wing of the Liberator.

The other picture shows a Focke Achgelis Fa 330 submarine-borne rotor kite. Aircraft in background are the Lincoln prototype and the early incomplete pre-production example of a Westland Wyvern Mk 1. The tail on the left is that of the Tempest.

The Firth FH-1 in particular has, to my knowledge, not yet been illustrated anywhere.

Parkstone, Dorset. JOHN GAYLARD.

THE INDUSTRY

Teddington Controls: a Name-change

EXPANSION of the Teddington group has, for some time past, resulted in the formation of new companies each specializing in a particular field of automatic control. To indicate that Teddington Controls, Ltd., are engaged exclusively on work in connection with the aircraft industry, the name is to be changed, from February 1st, to Teddington Aircraft Controls, Ltd.

Considerable progress has been made by the company since it moved to South Wales in January 1946. Factory space has doubled and is now 143,000 sq ft, and employment is provided for 1,300 people. The range of the company's products includes virtually all forms of temperature and pressure control as applied to aircraft, the principal examples being cabin temperature control and fuel-tank pressurization systems. For use in these installations there is a full range of hot-air valves, pressure switches, vent valves and related equipment.

A Teddington motor-operated time switch is used in the starting circuit of the majority of British aircraft gas turbines, and variants of this switch control the cylic functions of numerous wing and engine de-icing systems. The company also produces stainless-steel bellows of up to 4ft diameter, and even larger sizes will be made when the installation of new plant is completed.

Glass-fibre Progress

RECENT developments in glass-reinforced plastics for the aircraft industry have included moves in the direction of further improving the fire-retardant qualities of the material, and grades suitable for use in passenger aircraft—e.g., in such situations as luggage compartments—are now available.

General characteristics of glass-reinforced plastics—which have been used for an increasing number of applications in the aircraft industry during the past ten years—are now well known. Nevertheless, some of these facts still make surprising reading. Figures given by Fibreglass, Ltd. (Ravenhead, St. Helens, Lancs), show that these materials can be as strong as steel and lighter than, or as light as, aluminium. The *specific* tensile-strength lies between 1,200 and 30,000 lb/sq in (steel is about 9,000 lb/sq in and aluminium between 4,000 and 14,000 lb/sq in). For equivalent tensile strengths, reinforced plastics are the lightest rigid materials known. The impact strength is also extremely high, while the material is proof against most normal forms of corrosion.

In a review of raw material supply situation, Fibreglass, Ltd., say that there are no limitations of the supply of either glass fibres or resins. As regards glass fibres, most of the raw materials are easily available in this country; a few ingredients like borax have to be imported, but in relatively small quantities.

Something to Celebrate

GUESTS from the whole of the aircraft industry, and from foreign airlines, attended the annual dinner and dance of L. A. Rumbold and Co., Ltd., held at the Cumberland Hotel, London, on January 14th.

When Rumbolds assume the party spirit business is put completely on one side; after-dinner speeches were brief, and no mention was made of the firm's recent achievements. During the past twelve months, however, they have produced nearly 2,000 specialized seats of 50 different types—and this figure does not tell the whole story, because many of the seats were doubles and trebles. The varieties include a complete non-magnetic type for inshore minesweepers, and between 50 and 60 aircraft have been furnished. Also in production are "super-lightweight" seats for use in helicopters; for these a weight of 18 lb for a double seat has been mentioned.

A series of ten sample seats of various types has been sent to Russia, whence it is hoped to obtain substantial orders.

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PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate scheduled air services:—

FROM:—Eagle Aviation, Ltd., of 29, Clarges Street, London, W.1.

APPLICATION No. 160/1. For amendments to the terms of the approval given by the Minister of Transport and Civil Aviation for operation during the period up to 31st August, 1960 of an Air-Freight Service on the route Manchester and/or Birmingham-Dusseldorf or Frankfurt-Copenhagen-Stavanger-Oslo-Stockholm-Gothenburg-Copenhagen-Dusseldorf or Frankfurt-Birmingham and/or Manchester (Application No. 160) so as to permit optional traffic stops at Stavanger, Oslo, Stockholm and Gothenburg and also the inclusion of a traffic stop at Hamburg.

APPLICATION No. 451. For a Seasonal Inclusive Tour Service with Dakota aircraft in conjunction with Whitehall Travel Ltd., for the carriage of passengers and supplementary freight between London (Blackbushe) and Palma at a frequency of one service weekly during the season from May to October inclusive each year, for a period of seven years, commencing 1st May, 1955.

APPLICATION No. 453. For a Colonial Coach Service with Viking aircraft for the carriage of passengers and supplementary freight between London (Blackbushe) and Cyprus (Nicosia) with an intermediate traffic stop at Malta and with technical stops only at Nice and Heraklion at a frequency initially of one service fortnightly increasing thereafter according to demand during the period from 1st July, 1955 to 30th July, 1962.

APPLICATION No. 452. From East Anglian Flying Services, Ltd., of Southend Airport, Southend-on-sea, Essex. For a normal Scheduled Service with D.H. Dove and D.H. 89A aircraft and later possibly with D.H. Heron and/or Dakota aircraft for the carriage of passengers, supplementary freight and mail between Ipswich and Rotterdam and/or Ypenburg with an intermediate traffic stop at Southend at a frequency of up to 30 services weekly with duplication of flights when necessary for a period of 10 years commencing from date of approval.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [3199

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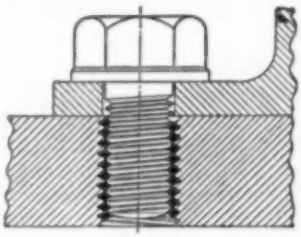

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Principal: P. F. R. Venables, B.Sc., Ph.D., F.R.I.C.

Applications are invited for the following posts:—

(a) Senior Lecturer in the Department of Mechanical Engineering.

Applicants should hold an honours degree or equivalent qualification and should have had teaching and industrial and/or research experience. Ability to develop research work and supervise research students will be regarded as an advantage. The successful candidate will be required to teach general mechanical engineering subjects to Higher National Certificate standard and to offer at least one subject to Final B.Sc.(Eng.) and Higher National Diploma standard. The salary will be in accordance with the Burnham Technical Report, 1954, £1,065 by £25 to £1,215. The successful candidate will be required to commence duty on April 1st, 1955, or as soon as possible thereafter.

(b) Lecturer in the Department of Mechanical Engineering

Applicants should hold an honours degree or equivalent qualification and should have had both teaching and industrial experience. The successful candidate will be required to teach general mechanical engineering subjects to Higher National Certificate standard and to offer specialized subjects in either production engineering or aeronautical engineering. The salary will be in accordance with the Burnham Technical Report, 1954, £965 by £25 to £1,065. The successful candidate will be required to commence duty as soon as possible.

Forms of application and further particulars of these appointments may be obtained from the Principal, Royal Technical College, Salford 5, to whom forms should be returned as soon as possible.

R. RIBBLESDALE THORNTON,
Clerk to the Governors.
[3183

MINISTRY OF TRANSPORT AND CIVIL AVIATION. Inspectors of Accidents. Applications are invited from men for one post for senior inspector and two posts for inspector in the Civil Aviation Accidents Investigation Branch, H.Q. in London but duties involve investigations in any part of the world. Age at least 30 on December 1, 1954. Candidates must be of good education, able to compile technical reports and have sound knowledge of engineering, particularly in aeronautics. They must have held an Airline Transport Pilot's Licence, Commercial Pilot's Licence or equivalent pilot's "B" licence and considerable flying experience, with not less than 1,000 hours as pilot-in-charge. Remuneration for 45½ hour week, senior inspector £1,398 rising to £1,620, inspector £1,150 rising to £1,366. Appointments initially unestablished but good prospects of establishment.

APPLICATION forms and particulars from Ministry of Transport and Civil Aviation, Establishments/Staffing B.1., Room 6057, Berkeley Square House, London, W.1. Application forms to be returned by February 16th, 1955. [3182

ENGINEERS and Physicists required by Ministry of Supply for posts in Instrumentation Section of Royal Aircraft Establishment, Farnborough, Hants. 1, Research in techniques and instrumentation for measuring and recording of physical quantities arising from tests in aircraft and missiles. An interest in application of physical principles to design of special measuring instruments would be useful (2 posts). 2, Research on electronic circuits and equipment for flight test, wind tunnel and allied aeronautical research purposes. Qualifications: 1st or 2nd class hons. degree or equivalent in physics or engineering. Some relevant experience may be an advantage. Appointments in grade of scientific officer within salary range £457/10/-£845. Women somewhat less. F.S.S.U. benefits may be available. Application forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1., quoting A13/5A. [3193

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DRAUGHTSMEN TECHNICIANS—LOFTSMEN

The Bristol Aeroplane Company Limited is centralising its London Aircraft Design Offices in Haymarket House, Haymarket, London, S.W.1, and is expanding its design team.

A unique opportunity is offered to experienced draughtsmen, technicians and loftsmen to join design teams engaged upon Civil and Military Aircraft contracts, in both the fixed wing and rotating wing fields.

A progressive CAREER is offered, where ABILITY merits RAPID PROMOTION; where the FINEST WORKING CONDITIONS are being built up in the most CENTRAL POSITION IN LONDON, where SALARIES are appropriate to experience and qualifications, and where a contributory PENSION SCHEME ensures the FUTURE.

The following are required:—

(*a*) **Intermediate, Senior and Design Draughtsmen** for the Structures, Systems, Electrics and Mechanical Sections. Some Juniors may be considered for training.

(*b*) **Intermediate and Senior Loftsmen** for the aircraft Full Scale Layout Section.

(*c*) **Intermediate and Senior Technical Engineers** for the Structures Analysis and Aeroelasticity Sections. A degree or Higher National Certificate in Aeronautical, Mechanical or Structural Engineering is required.

(*d*) **Weights Engineers** for the Weight Estimating and Control Section.

Applications, giving details of experience, qualifications, quoting L.D.O.1, should be addressed to the **Design Administration Engineer, The Bristol Aeroplane Company Limited, Aircraft Division, Filton House, Filton, Bristol.** Interviews can be arranged either in London or Filton.

ROTOL/BRITISH MESSIER LIMITED

Applications are invited from Graduate Engineers and other suitably qualified men (H.N.C. standard minimum) for the following appointments.

Research Engineers
Aerodynamicists
Electrical Design and Development Engineers
Test Engineers
Technical Assistants
Design Draughtsmen
Jig and Tool Draughtsmen
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Vacancies also exist for:—

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Technical Writers
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Companies are engaged upon long-term projects relating to aircraft propellers, landing gear, auxiliary gearboxes, bleed and ram air turbines, hydraulic and electro-hydraulic devices, servo-mechanisms, and fuel flow proportioners.

The above posts offer interesting and progressive positions to men of suitable qualifications and experience. The Factory is pleasantly situated between Gloucester and Cheltenham, and working conditions are good. Superannuation and Welfare Schemes are in operation and excellent Sports and Social facilities exist.

Applications should be addressed to the

Personnel Manager, Messrs. Rotol/British Messier, Ltd., Cheltenham Road, Gloucester.

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SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

THE DE HAVILLAND AIRCRAFT CO., LTD., Airspeed Division, Christchurch, Hants, require additional design draughtsmen (structural, mechanical and electrical) and loftsmen. See press reports of new design and development work.—Application to: The Chief Draughtsman. [3150

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are required by the

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of the

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for work of a technical administrative and co-ordinating nature. Preference will be given to an applicant with an engineering degree and experience in the field of aircraft radar and control Servo Systems. A knowledge of design for component production is desirable.

Aeronautical, Electrical and Mechanical Engineers

for technical supervisory work, preferably with engineering degree, some administrative experience in aircraft or associated industries. Housing assistance may be given in special circumstances.

Engineer

preferably with engineering degree and some practical flight testing experience in connection with aircraft, for the integration of trials activities in this country and abroad with regard to target requirements on guided weapon ranges. This work covers an extensive field of subjects.

THESE are senior, permanent appointments carrying attractive salaries for the right men with staff pension after qualifying period. Applications to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 254 P. [3185

TECHNICAL ASSISTANTS—MALE & FEMALE

ARMSTRONG SIDDELEY has vacancies for:—
(1) Technical assistants in the departments of vibration, structural testing, balancing and engine test recording.
(2) Two engineers for electronic section.
(3) Design draughtsmen for design work.
(4) Instrument work on strain gauges. Dexterity with fingers essential.

APPLICANTS should have at least a higher National Certificate in Mechanical Engineering for (1) and Electrical Engineering for (2). Salary and prospects good.—Apply to Reference CG/ME5, Technical Personnel Manager, Armstrong Siddeley Motors, Coventry. [3135

DE HAVILLAND AIRCRAFT CO. LTD.

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CHRISTCHURCH

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SENIOR AND INTERMEDIATE STRESSMEN

With adequate experience required for expanding office engaged in work on existing and new types of high-speed aircraft.

Minimum qualifications are Higher National Certificate or B.Sc. (Eng.) with appropriate subjects.

Attractive salaries will be paid to those applicants having suitable experience and training.

Excellent superannuation and pension schemes in operation.

Applications for interview should be made to the CHIEF STRESSMAN at the above address.

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Personnel possessing determination and initiative are being sought and these qualities are at least as important as actual experience.

A good salary will be offered to applicants satisfying the above requirements.

Successful applicants will be given some assistance towards securing accommodation or purchasing a house.

Applications should be forwarded to the

CHIEF DESIGNER

The Helicopter Division OF SAUNDERS-ROE LTD. at SOUTHAMPTON AIRPORT

are enlarging their Design Team and invite applications for the following vacancies:—

1. **Senior Technical Engineer**
   This post carries considerable responsibility and requires a knowledge of helicopter aerodynamics and vibration problems. A Degree is essential, preferably with Honours.
2. **Senior Stressman**
   Preferably with a Degree and at least four years' experience in aircraft stressing. Helicopter experience would be an advantage.
3. **Technical Engineer**
   Technical engineers are required for work on helicopter aerodynamics, performance and vibration analysis and for project investigations. A Degree or H.N.C. is a requirement.
4. **Intermediate Stressman**
   With experience in aircraft stressing. A University Degree or H.N.C. is desirable.
5. **Design Draughtsmen**
   For design work on helicopter airframes, transmissions and test equipment.

Salaries will be commensurate with age and experience. Please apply to: **Personnel Officer, Saunders-Roe, Ltd., East Cowes, Isle of Wight.**

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Have immediate vacancies for:—

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TWO DRAUGHTSMEN (INTERMEDIATE)

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The work is of a varied and interesting nature on many different types of aircraft.

Salaries and long term prospects are excellent. Practical assistance given with the housing problem where necessary.

Applications with full details and stating when available for interview to

PERSONNEL MANAGER
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THE BUILDINGS DIVISION
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THE BRISTOL AEROPLANE COMPANY, LIMITED

HAS entered into a new field of activity in constructional engineering. The scope covers design, development and production of orthodox and prefabricated forms of constructions, including building elements and a wide range of interesting projects.

Vacancies exist for the following:—

(1) Senior draughtsmen of at least Higher National Certificate standard for preparing steelwork plans and details. Some knowledge of design and site surveying desirable.
(2) Junior draughtsmen improvers of Ordinary National Certificate standard with steelwork detailing experience.
(3) Senior draughtsmen of Higher National Certificate standard with experience in metal window design.
(4) Senior draughtsmen of Higher National Certificate standard with general engineering experience.
(5) Senior draughtsmen of Higher National Certificate standard experienced in light alloy design.

The offices are situated at Banwell, on the outskirts of Weston-super-Mare in pleasant surroundings. Adequate transport facilities are available. Superannuation, benevolent and welfare schemes are in operation, together with excellent canteen facilities. A normal five-day week is worked with overtime.

Applicants should apply to The Chief Engineer, Bristol Aeroplane Company, Limited, Buildings Division, Banwell, Somerset, giving full particulars of experience, qualifications and present salary. [3162

DRAUGHTSMEN-CHECKERS
are required by
THE ENGLISH ELECTRIC CO., LTD.
for their
LUTON AND STEVENAGE WORKS.

APPLICANTS should have good workshop experience supplemented by at least 5 years' drawing office service, with specialist knowledge of at least one of the following:

Electronics—Instruments
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Hydraulics

THESE positions carry good salaries and are pensionable after qualifying period. Housing assistance may be given in some cases.

APPLICATIONS, quoting reference 178A, should be sent to Dept. C.P.S., 336/7, Strand, W.C.2. [3206

TECHNICAL ASSISTANTS FOR FLIGHT AND PERFORMANCE

ARMSTRONG SIDDELEY MOTORS require young engineers interested in tests covering performance measurement, handling and control behaviour, analysis of flight test data, prediction of engine performance and the functional side of engine behaviour. Applicants must possess a Degree or Higher National Certificate in Mechanical Engineering. Applications quoting reference CG/FP4, to the Technical Personnel Manager, Armstrong Siddeley Motors, Coventry. [3148

JUNIOR DRAUGHTSMAN
required

aged 22 years or over, for interesting work on aircraft seating, design, etc. Aircraft or engineering experience an advantage but not essential. Apply by letter to:—L. A. RUMBOLD, & CO., LTD., Kingsgate Place, Kilburn, London, N.W.6. [3196

ARMSTRONG SIDDELEY MOTORS, Coventry, have vacancies for

Technical Writers
Planning Engineers

for work on gas turbine aero engines. Apply to Reference DI, Personnel Manager, Armstrong Siddeley Motors, Coventry. [3188

STRESSMEN required.

VACANCIES exist in the stress office of the Gloster Aircraft Co., and applications are invited from qualified men, particularly those with a University degree and one or two years stressing experience. Apply in first instance giving full particulars of technical qualifications, age, experience and salary to: The Chief Designer, Gloster Aircraft Co., Ltd., Gloucester. [3152

INSPECTORS required by Skyways, Ltd., at Bovingdon and Stansted Airports. Experienced on Hermes and York aircraft, preferably with "A" or "C" licences.—Apply Personnel Manager. Skyways, Ltd., 7 Berkeley Street, London, W.1. [3151

VICKERS-ARMSTRONGS LIMITED (Aircraft Division)

require:—

(l) **AIRCRAFT SERVICING ENGINEERS**
(airframe and electrical) with ARB Licences endorsed (for airframe) for Viking and/or four-engined aircraft; for representatives' work on civil aircraft in this country and overseas.

(m) **AIRCRAFT FURNISHING DRAUGHTSMEN**
with experience but not necessarily highly qualified in aircraft design.

(n) **ELECTRICAL ENGINEERS**
with Higher National Certificate at least, and electrical draughtsmen required for development work on the electrical and radio systems of modern and future aircraft. Aircraft experience is desirable, but not essential with good electrical background.

(o) **DESIGN DRAUGHTSMEN**
for Wind Tunnel Design Office, with experience, preferably, in model design or light mechanical engineering.

(p) **INSPECTORS**
(airframe and electrical) for work on civil and military finals; also other branches of production and development. Applicants should state any ARB licences held—quoting groups.

(q) **FITTER-ERECTORS and ELECTRICAL WIREMEN**
Skilled and/or experienced semi-skilled on aircraft production in main Erecting Shop at Weybridge; also preparation of flight and experimental work at Wisley Aerodrome (between Cobham and Ripley).

(r) **CLERKS**
of good ability for work in our Time, Wages, Accounts and Buying Offices and other Departments. Previous experience of these particular types of offices not essential. Applicants should, however, be competent in figure work.

Applications, quoting date and prefix letter of advertisement, to:

EMPLOYMENT MANAGER,
(AIRCRAFT DIVISION)
VICKERS-ARMSTRONGS, LTD.,
WEYBRIDGE WORKS
WEYBRIDGE, SURREY

Weybridge is 30 minutes from London on the main Waterloo/Portsmouth line. Additional 'buses operate to and from the Works at starting and finishing times. Canteen facilities.

Applicants should be in a position to arrange their own housing accommodation. Assistance can only be given with individual lodgings.

SITUATIONS VACANT

ASSISTANT to professor of aeronautics.

GRADUATE in aeronautics or mechanical engineering required as assistant to professor of aeronautics at the Technical University of Norway, Trondheim. Commencing salary 11,600 kr per year (£580). Applications with full particulars and copies of testimonials to Secretary, NTH., Trondheim, not later than February 15th, 1955. [3177

BRITISH EUROPEAN AIRWAYS require for their Project and Development Branch, London Airport:—

(i) Technical authors, with comprehensive knowledge of aircraft construction, several years' experience in preparation of technical publications. Salary scale £700-£820 p.a.

(ii) Assistant technical authors. Salary scale £10/2/- to £12/7/- p.w. or £675-£725 p.a., according to qualifications and experience.

AFTER qualifying periods, pension and sick pay schemes, air travel concessions, three weeks' annual holiday.—Apply, in writing, giving full particulars to Senior Personnel Officer, B.E.A. Engineering Base, London Airport, Hounslow, Middlesex. [3187

A. V. ROE AND COMPANY, LIMITED, have the following vacancies in the Electronics Laboratory at Greengate:—

(a) Technicians are required who possess a degree in physics or electrical engineering for work on the development of electronic computing equipment for use in the design office. The electronics department is expanding and is likely to take in many diverse fields of development. Preference will be given to applicants who have had some practical experience.

(b) Technicians are also required who possess an honours mathematics degree for work in connection with programming digital computors which will involve the breaking down of differential equations of the type met with in aircraft structural analysis into forms suitable for arithmetical analysis.

Applications, stating full details of age, qualifications and experience, should be addressed to the Labour Manager, A. V. Roe and Company, Limited, Greengate, Middleton, Manchester. [3180

STARWAYS require captains with Dakota experience. ALTP or Senior Commercial licence with instrument rating.—Apply: Starways, Limited, Liverpool Airport, Liverpool, 19. [3146

FITTERS, skilled men for complete aircraft construction, permanent jobs, excellent opportunities, new substantial company, London area, good conditions and pay. Reply details of experience to Box 1211. [3198

A SCIENTIST OR ENGINEER

is required by a

well-known Aircraft Company

to lead and administer

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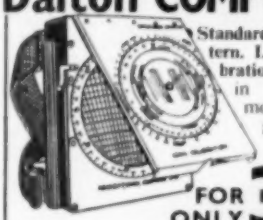

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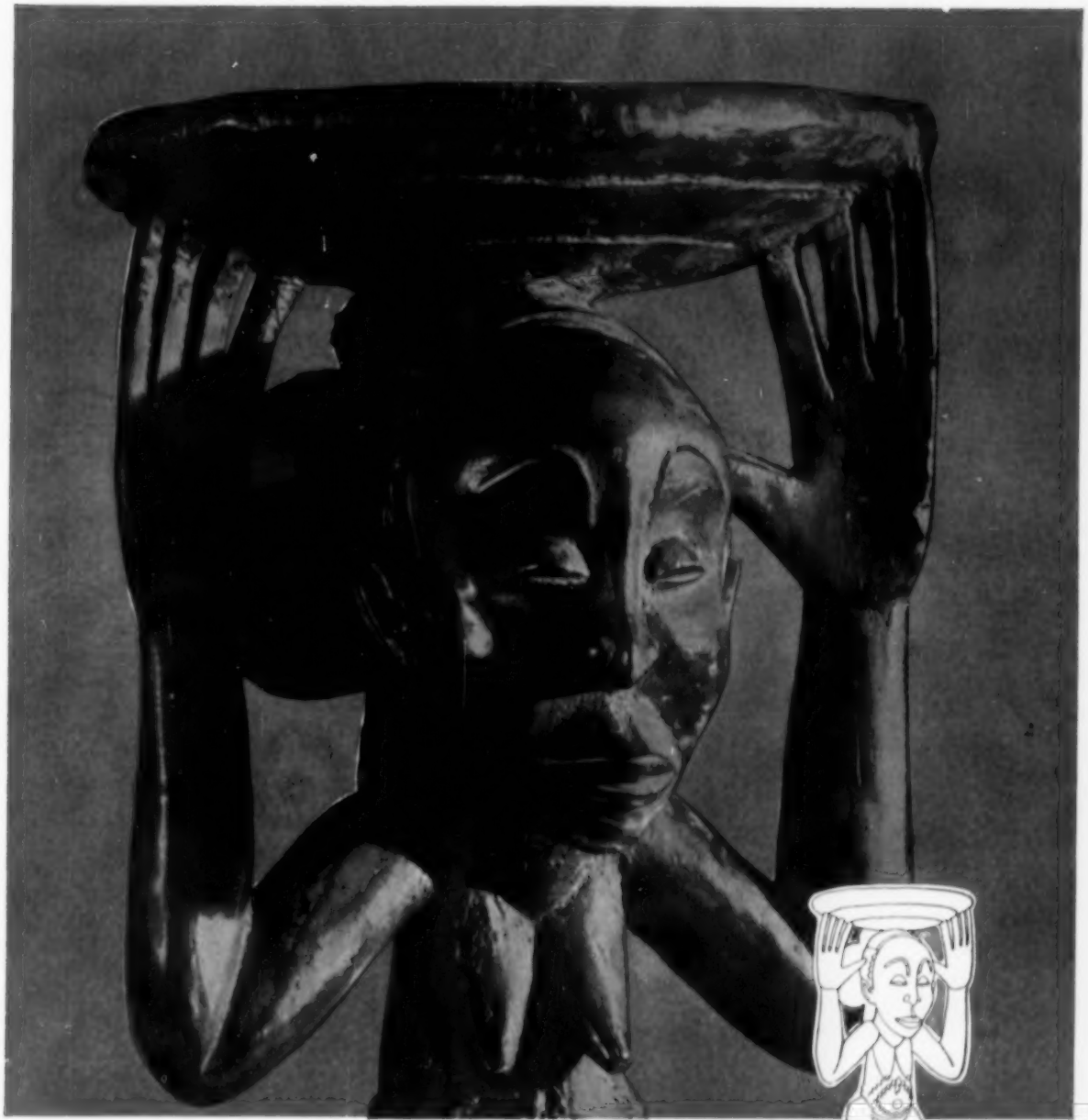

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